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THE JOSEPH LEIDY LECTURE

INTRODUCTION BY THE PROVOST OF THE UNIVERSITY OF PENNSYLVANIA

JOSEPH LEIDY was a son of the University of Pennsylvania. As a token of reverence and affection his devoted nephew and namesake, Joseph Leidy, Jr., has generously endowed the Joseph Leidy Memorial Lectureship for the extension of scientific knowledge through the medium of lectures by eminent specialists.

To-night, we meet to inaugurate this foundation. Of Dr. Leidy, the great student and teacher, whom many of us knew and deeply honored, I would say:

"The wisest man could ask no more of fate
Than to be simple, modest, manly, true,
Safe from the many, honored by the few;
Nothing to count in world, or church, or state,
But inwardly in secret to be great;
To feel mysterious nature ever new,
To touch, if not to grasp, her endless clue,
And learn by each discovery how to wait,
To widen knowledge and escape the praise;
Wisely to teach because more wise to learn;
To toil for science, not to draw men's gaze,
But for her love of self denial stern;
That such a man could spring from our decays
Fans the soul's nobler faith until it burn."

EDGAR F. SMITH

A TRIBUTE TO JOSEPH LEIDY[1]

JOSEPH LEIDY was a Philadelphian by his birth, by his career and by his death, and no citizen of this metropolis has more deserved public honor than he.

Leidy was born September 9, 1823, and died April 30, 1891. His first scientific paper was published in 1845, and his last

[1] Opening address for the Joseph Leidy Foundation delivered at the University of Pennsylvania, April 17, 1913.

in 1891. For forty-six years he was an active contributor to SCIENCE. The list of his publications, prepared by his nephew, gives 597 titles. A large part of these are brief communications to the Academy of Natural Sciences in Philadelphia, but the list includes also a series of articles and memoirs, some of them of considerable extent, and all valuable. Leidy's investigations are among the classics of American science.

He represents a type of scientific man which seems in our days of specialization and of elaborate laboratories almost extinct. He was a naturalist, and was one of the group of four distinguished true naturalists who have done most for the introduction of natural science into American life. These four men—Louis Agassiz, Spencer F. Baird, James D. Dana and Joseph Leidy—were contemporaries. They all took a similar view of nature. She was a whole made up of many parts played together, and they were interested in the whole drama. Their delight was to go forth and see the world and watch the coordinated working of its parts. The correlation between living beings and physical forces appealed to them. They were quite untouched by what we may call the "laboratory spirit," which has arisen since their time—that spirit which isolates an object or phenomenon indoors in order to apply to it all the finest resources of modern scientific equipment. These men, on the contrary, went out of doors to see and study, and the spoils which they brought home were investigated without any elaborate appliances. Young zoologists, botanists and geologists of to-day find these methods too toilsome. In one passage Leidy points out that the studies of the living fauna of our streams and ponds may be carried on by a simple microscope, such as even our elementary students of to-day would scarce deign to use, yet how varied, interesting, and even wonderful the observations which Leidy has recorded! One has only to look through his collected researches in helminthology and parasitology, published by the Smithsonian Institution in 1904, to gain a clear impression of the enormous extent and variety of these observations. He searched all sorts of animals, insects, vertebrates, molluscs and found a great number of parasitic plants and animals, concerning which he reports many original observations. Many of the species discovered were new to science and were named by him. Nearly the whole of the material he studied was collected by himself, for the most part on little trips he made in the neighborhood of Philadelphia. I quote his own quaint reference to these excursions:

> "Going fishing?" How often the question has been asked by acquaintances, as they have met me, with rod and basket, on an excursion after materials for microscopic study. "Yes!" has been the invariable answer, for it saved much detention and explanation; and now, behold! I offer them the results of that fishing. No fish for the stomach, but, as the old French microscopist Joblet observed, "some of the most remarkable fishes that have ever been seen"; and food-fishes for the intellect.

Although professor of anatomy at this university for a long time (1858–1891), his heart was always in his natural-history studies. He did, to be sure, write a textbook of anatomy, undertaken, it is said, only after much urging by the publisher, but it was only an unessential episode in his life. Yet he knew how to use his anatomical opportunities, and he has given us valuable notes on the inter-maxillary bone in man, on the structure of the liver, on reversal of the viscera, etc. But his real life was the exploration of nature. He acquired intimacy not only with animals, the chief objects of his study, but

also with plants, stones and minerals. He collected extensively, his herbarium which he presented to the university contained over 1,500 species, all determined by himself, and his mineralogical collection has been described as "very fine and valuable" and was purchased by the National Museum in Washington. But his chief collections were of animals, especially of such as offered opportunity for microscopical study. The quotation read a few moments ago refers to his gathering of fishes—the particular "fishes" in this case were the Rhizopods. His monograph of this group of unicellular animalcules appeared in 1879 as one of the quarto volumes of the Hayden Survey, and contains a vast amount of original observation and is illustrated by thirty plates, after his own drawings of the living animals. Another extensive work was entitled "Flora and Fauna within Living Animals," one of the most important contributions to parasitology we possess. It was published in 1851 by the Smithsonian Institution in Washington, and is illustrated by ten exquisite copper plates, so skillfully engraved by Oudet that they worthily reproduce the author's beautiful drawings.

The range of work we have already indicated is sufficient to more than occupy an able man, and the results published by Leidy in the field of zoology proper would alone suffice to assure his place among the most distinguished investigators of America. His actual reputation, however, rests at least in equal measure upon his achievements in vertebrate paleontology, which received a richly deserved recognition when the Geological Society of London awarded him in 1884 the Sir Charles Lyell medal. His monographs on American fossil vertebrates laid the foundations of our present knowledge, and first marked out the way by following which Cope and Marsh and their younger successors have attained distinction. Mention may be made especially of the first memoir of the series, "The Ancient Fauna of Nebraska, a Description of Extinct Mammalia and Chelonia from the Mauvaises Terres of Nebraska," published in 1854 in the sixth volume of the Smithsonian Contributions to Knowledge. The wonderful Eocene deposits of the Bad Lands had not been long known, and the collections available had been hardly more than skimmings from the surface. Leidy by the friendly cooperation of the few collectors of the time was able to inspect practically all the remains which had been gathered. The plates are superb lithographs drawn by the talented Sonrel. In 1855 followed the memoir on the Sloths, in 1865 on the Cretaceous reptiles, and other memoirs in later years (1869, 1873 and 1877).

A special extraneous interest attaches to Leidy's paper on the extinct sloths, for it includes a careful description of *Megalonyx Jeffersoni*, the first remains of which were discovered in Virginia and were described by no less a person than Thomas Jefferson at a meeting of the American Philosophical Society on March 10, 1797. The bones were soon after identified by Dr. Caspar Wistar as not those of a carnivore, as thought by Jefferson, but of a sloth. Casts of these bones were sent to Cuvier, who studied them. I am told that the originals, collected by Jefferson, are now in the collection of the Academy of Natural Sciences in this city.

It happened that the study of vertebrate paleontology in the seventies and eighties of the last century was pursued with great zeal, but also unfortunately with certain rivalries, which aroused acrimonious feelings, too often publicly expressed. Leidy shrank from controversy and it is said that rather than risk being entangled in dis-

putes, so little to his taste, he withdrew from paleontological work altogether.

Leidy was a student of facts, a lover of positive knowledge. His attitude is indicated by the following words from the preface to his article on the extinct mammalia of Dakota (1869):

> The present work is a record of facts. . . . No attempt has been made at generalizations or theories which might attract the momentary attention or admiration of the scientific community.

Note the implied scorn of hasty speculation, and remember that in 1869 most biologists had been carried off their feet by the whirlwind of speculation which arose in the wake of the Darwinian theory. Leidy remained undisturbed, a firm devotee of objective research.

Leidy's connection with the Philadelphia Academy of Natural Sciences was long and intimate. His earliest publication known to me was a communication to the academy in 1845. Two years later he became chairman of the board of curators; the collections of the academy long profited by his devotion and wide knowledge of natural history. From 1881 until his death he was president.

For nearly fifty years Leidy was a constant attendant at the meetings of the Philadelphia Academy and very often had matters of interest to communicate, many of which are briefly recorded in the *Proceedings*. Sixty years ago the meetings of local scientific societies had an importance and a charm, which have been much diminished by the developments of the last twenty-five years. A generation ago there were fewer specialists, and narrow interests did not dominate the majority of scientific workers as much as to-day. When naturalists met they spoke a common language, and were mutually interested in one another's discoveries—sixty years ago. There were no national special societies, and no express trains to bring the members together for three days, and to scatter them asunder for three hundred and sixty-two days—sixty years ago. The knowledge of the individual was less intensive, but his outlook was broader—sixty years ago. To this old order—now passed forever—Leidy belonged. The range of his interests and of his contributions, as revealed by a careful study of the *Proceedings of the Academy of Natural Sciences*, is astonishing, if viewed from the standpoint of cotemporary specialization. There are statements in his usually brief notes in the *Proceedings* concerning regeneration in Planarians, the formation of the cell wall *after* the division of the cells, on the occurrence of internal parasitic plants in various animals, on bacteria in the intestine of toads, the sense of smell in snails, on a new fossil, on the structure of cartilage, parasitic worms, sponges, Infusoria, Rotifera, Annelids, extinct reptiles, fishes, parasitic Hymenoptera—all incidental and in part accidental observations, but reported with unfailing accuracy.

It should be recorded that time has greatly emphasized the importance of some of Leidy's original discoveries, as of the existence of a bacterial flora in the intestine (1849). Particularly noteworthy are his experiments with cancer, made in 1851.[2] He transplanted small fragments of a human cancer under the skin of a frog and found that they maintained themselves for a long period. At the close of the communication, the author says:

> The experiment not only proved the independent vitality of the tissues, which was generally admitted, but also rendered it extremely probable that cancer was inoculable, for, as in the experiments, the cancerous fragments continued to live when introduced into cold-blooded animals, they

[2] *Proceedings Acad. Nat. Sci., Philadelphia*, V., p. 212.

would probably not only continue to live when introduced into warm-blooded animals, but would grow or increase in size.

The transplantation of tumors has become an important method of pathological research. We should not forget that Leidy originated the method.

Leidy's supreme gift was the ability to see, coupled with an inexhaustible delight in seeing. He saw so well not only with his eye, but with his intelligence and interpreting mind, that his published observations maintain a level of accuracy to which few naturalists have risen. His characteristic accuracy shows equally in his brief notes and in his extended monographs—it seems never to have failed. Dr. Thomas G. Lee says of Leidy's publications that they "probably contain fewer errors of fact and interpretation than those of any other writer on so many and such varied subjects." The joy of seeing is an inborn gift. It manifested itself very early in Leidy and was accompanied by a talent for drawing. This talent was so marked in the boy that his father withdrew him from school when he was sixteen, with the idea of educating him as an artist. But at this age he was already a naturalist, a student of nature by spontaneous instinct. He dissected cats, chickens and other animals and showed such intense interest in comparative anatomy that it was decided that the lad should study medicine. He attended lectures on medicine at the University of Pennsylvania and obtained the degree of doctor of medicine in 1844, and for two years actually practised. In 1846 he was demonstrator of anatomy in Franklin Medical College, and in 1847 he became a teacher in the university under Dr. Horner. In 1850 he had the great advantage of a trip to Europe with Dr. George B. Wood, to collect material to illustrate Dr. Wood's lectures. It gave the young naturalist fresh stimulus, for he made the acquaintance of a number of famous anatomists and physiologists. The late Mr. Isaac Hinckley was fond of relating how Dr. Wood found it difficult to persuade Leidy to overcome his modesty so far as to send in his card also to Johannes Müller. Presently Müller came into the room, crying out, "Which is Leidy?" Extreme modesty was a marked characteristic of Joseph Leidy throughout his life, and was accompanied by an amiable unselfishness, which endeared him alike to his friends and his students. In 1858, after the death of Dr. Horner, Leidy was made professor of anatomy in the university and continued to fill the chair until his own death, thirty-three years later.

Leidy's death terminated the career of a man whose noble and unflagging devotion to science secured a rich harvest of discovery. He has left a message to us which I deliver to you in his own words:

> The study of natural history in the leisure of my life, since I was fourteen years of age, has been to me a constant source of happiness; and my experience of it is such that independently of its higher merits, I warmly recommend it as a pastime, which I believe no other can excel. At the same time, in observing the modes of life of those around me it has been a matter of unceasing regret that so few, so very few, people give attention to intellectual pursuits of any kind. In the incessant and necessary struggle for bread we repeatedly hear the expression that "man shall not live by bread alone," and yet it remains unappreciated by the mass of even so-called enlightened humanity. In common with all other animals, the engrossing care of man is food for the stomach, while intellectual food too often remains unknown, is disregarded or rejected.

It is an honor to Philadelphia that the statue of Joseph Leidy stands by the great city hall. It is an honor to the University of Pennsylvania that his name is to be from this evening forth associated with the university's highest work. We are gath-

ered here to express our reverence for the man and our admiration for the scholar. It is our part to keep alive the tradition of truth-loving, of scientific devotion and of perfect modesty which is our legacy from Joseph Leidy.

Charles S. Minot

Heredity and Microscopical Research[1]

I have been much honored by the invitation to deliver the first lecture of a series established in honor of Joseph Leidy, a man distinguished alike for the diversity and importance of his original contributions to knowledge and for the far-reaching influence that he exerted on other men of science, in his own time and after. No American naturalist could be named whose biological interests ranged over a wider field; and the selection of my topic this evening has been influenced in some measure by the fact that Leidy was an almost solitary pioneer of microscopical investigation in this country, at a time when the cell-theory was in the earliest stages of its development, and when no one could have imagined the brilliant future that lay before it. Did time permit I would gladly dwell for a moment on his early observations on the structure and division of cells, and on the activities of the simplest forms of life. Much of his subsequent work lay in a very different field of inquiry, but his interest in microscopical investigation never deserted him, witness to which was borne by the publication in his later life of a beautiful monograph on the fresh-water rhizopods, which at once took its place as one of the classics of American zoology.

[1] A lecture delivered before the University of Pennsylvania, April 17, 1913, on the Joseph Leidy Foundation. With the exception of three general diagrams it has been impracticable to reproduce the figures that were shown by means of lantern slides.

More than half a century has passed since Leidy's earliest studies with the microscope. The main motive power behind the unparalleled advance in biology during this period has been the persistent effort to explain the activities of living things through investigations upon their structure, whether anatomical, physical or chemical. This effort entered upon a new era with the discovery of protoplasm and the promulgation of the cell-theory; for its final objective was now seen to lie in minute structural elements, the cells, of which the tissues are composed. Little by little it became clear that the cell, whatever else it be, is a microscopic chemical engine, where the energy of the foodstuffs is finally set free, and applied to the work of life. The question inevitably arose whether we can discover within the cell any visible apparatus by which this is accomplished. The inquiry has a thousand aspects; I ask your attention to that which relates to the problem of heredity.

It long since became clear that the cell-theory offers us a general explanation of heredity. Heredity is a consequence of the genetic continuity of cells by division, and the germ-cells form the vehicle of transmission from one generation to another. This fundamental discovery divested heredity of the mystery in which it had so long been enveloped, though it must always remain among the most wonderful of phenomena. But this result only cleared the way for further advances. Our scientific curiosity is aroused in the highest degree by more specific problems of heredity. Why do individuals now and then appear that show little resemblance to their immediate progenitors but "revert" to much more remote ancestors? Why do the grandparents often exert definite effects upon their grandchildren of which no suggestion is given by their children? What

explanation can be offered of the combinations and recombinations of parental or grandparental characters that appear in definite numerical proportions in hybrids? We may glance at a few particular cases that will serve to place some of these questions before you in more concrete form. In the first view we see the results of crossing two distinct races of sweet peas, each of which is pure white and produces only white offspring so long as strictly inbred. On crossing the two races the hybrids are always deep purple, like the wild Sicilian species, and in this respect they no doubt revert to an early common purple ancestor of the two white races. The offspring of the hybrids include a variety of purple, red and white forms, among which are whites that are identical with the two original grandparents. Here is a somewhat similar case in domestic fowls. You see two different white races, each of which breeds true; but when crossed together they produce deeply colored hybrids, showing a pattern of plumage that is closely similar to that of the wild jungle fowl from which both white races are probably descended. How is the reversion shown in this and the preceding case to be explained?

Let us look at some more complicated phenomena. We have here the result of crossing two differently colored races of fowls, the barred Plymouth Rock and the black Langshan. If the barred cock be paired with the black hen, all the offspring are barred, like the father. If the barred hybrids be paired together the progeny includes, on the average, three barred to one black, and the black bird *is always a female*. Quite different, and even more singular, is the reverse cross shown in the next view, where the black cock is paired with the barred hen. Half the offspring are now barred and half black; and the remarkable fact is that the barred birds are all males, the black ones all females. In color pattern the sons are like their mother, the daughters like their father—an example of the so-called "criss-cross" heredity. Upon pairing these hybrids together, the following generation (grandchildren of the original forms) includes males and females of both types, barred and black. In the following view we see a quite analogous form of heredity, observed by Morgan in crossing a long-winged and a short-winged race of fruit-flies (*Drosophila*). When the male of a long-winged race is paired with the female of a short-winged race, all the sons are short-winged like their mother, all the daughters long-winged like their father. On pairing these two, the offspring are of all four types, long wings and short wings occurring in both males and females.

Such results seem at first sight capricious, almost fantastic, but this first impression is erroneous. The results are not capricious, but constant. The experiments may be performed over and over again, always with the same result, so that the outcome may be unfailingly predicted in advance; and this demonstrates that such forms of heredity, and heredity in general, must be due to some definite apparatus in the germ-cells. I shall try to show that microscopical research has revealed to us at least something of the nature of this mechanism, and that it has practically solved some of the very puzzles that have just been propounded. In order to indicate the nature of this solution, I must first ask attention for a moment to the so-called "unit-characters" and their behavior in heredity, on which the attention of both cytologists and experimenters on heredity has been largely concentrated in recent years.

Unit-characters have become too familiar to require more than brief illustra-

tion. Examples of them have just been seen in the colors of flowers or of plumage, and in the structure of the wings in flies. Their interest lies especially in the fact that they are transmitted independently of one another, as if they were separate and independent things. By appropriate crossing experiments, such as we have just seen, particular groups of such characters may be split up and recombined, over and over again, in constantly new combinations, with no alteration of their individual character. Let us look at one or two examples of this. Here are the results of crossing two different races of wheat (from experiments by Biffen). One parent is a bearded variety with short, dense heads; the other a beardless form with long, loose heads. The hybrid is intermediate in shape, and is beardless. On pairing the hybrids together all combinations of the four original characters, and of the hybrid character, appear in the grandchildren, namely, (1) short beardless, (2) short bearded, (3) hybrid bearded, (4) hybrid beardless, (5) long bearded and (6) long beardless. These six types appear in definite numerical ratios, and it is evident that the bearded or beardless character has been transmitted quite independently of the shape of the head.

Another and very striking case of the same kind is here seen, again from Morgan's experiments on fruit-flies. The grandfather has white eyes and yellow body color; the grandmother red eyes and gray body color. In the first generation all the offspring have red eyes and gray color. Among the grandchildren, however, appear not only both the original combinations but two new ones, namely, white-eyed grays and red-eyed yellows. Here again the second generation of hybrids shows all possible combinations of the four original unit-characters, white eye, red eye, yellow color and gray color. With a larger number of unit-characters the same would hold true, but the number of combinations would be much larger.

We catch a glimpse here of the methods by which the modern breeder of plants or animals is able to break up known combinations and recombine them into new types, somewhat as the organic chemist splits up known organic compounds and recombines the products into new compounds, perhaps unknown before. Our ability to do this is often of high practical value. As de Vries has said, most hybrids owe their character to a new combination of qualities. "It is the combination that is new," he says, "not the qualities themselves. Some characters are derived from one parent, others from the other. Each of these may be simply inherited, . . . but by their new combinations they yield varieties of higher practical value, and notable examples are afforded in those cases where one parent has contributed vigor of growth, hardiness in winter, resistance to disease or productivity, and the other bright flowers, palatable fruit or nutritive seeds." An example of this which he cites is Luther Burbank's celebrated white blackberry, produced synthetically by uniting in one race the light color of the fruit of an inferior variety of cultivated bramble with the large and succulent fruit of the Lawton blackberry. Another familiar example, also cited from Burbank's work, is the so-called Shasta daisy, which unites the desirable qualities of plants from three different continents. An English daisy has contributed its large flowers and tall, stiff stems; a Japanese species its whiteness of bloom; an American field daisy its profusion of flowers and hardiness in winter. Many other examples might be given to illustrate how by disassociation, recombination and selection desirable qualities may be brought together and undesirable ones eliminated; and by

this principle the improvement of domestic races of plants and animals is being attempted in many parts of the world to-day.

Now, it is obvious that we should be able to understand the behavior of unit-characters, at least in some degree, if it could be shown that they are somehow dependent individually upon separate structural elements or different chemical substances that may be separately transmitted through the germ-cells. It is just this which microscopical research and experimental researches on heredity, taken together, have demonstrated. They have accomplished more than this. They have not only shown with a high degree of probability how the transmission of unit-characters is effected, but have thrown at least some light on the question how the splitting up and recombination of particular groups of such characters takes place. The main part played by microscopical research has been to bring forward proof that the hereditary characters are somehow connected with separate bodies, contained in or formed from the cell-nucleus, and known as the *chromosomes*. Besides the chromosomes the cell also contains another kind of bodies found in the cell-protoplasm, and known as *chondriosomes* or *plastosomes*. These too are very likely connected with heredity; but their true significance has not yet become very clear, and we shall hardly have time to consider them within the limits of this address.

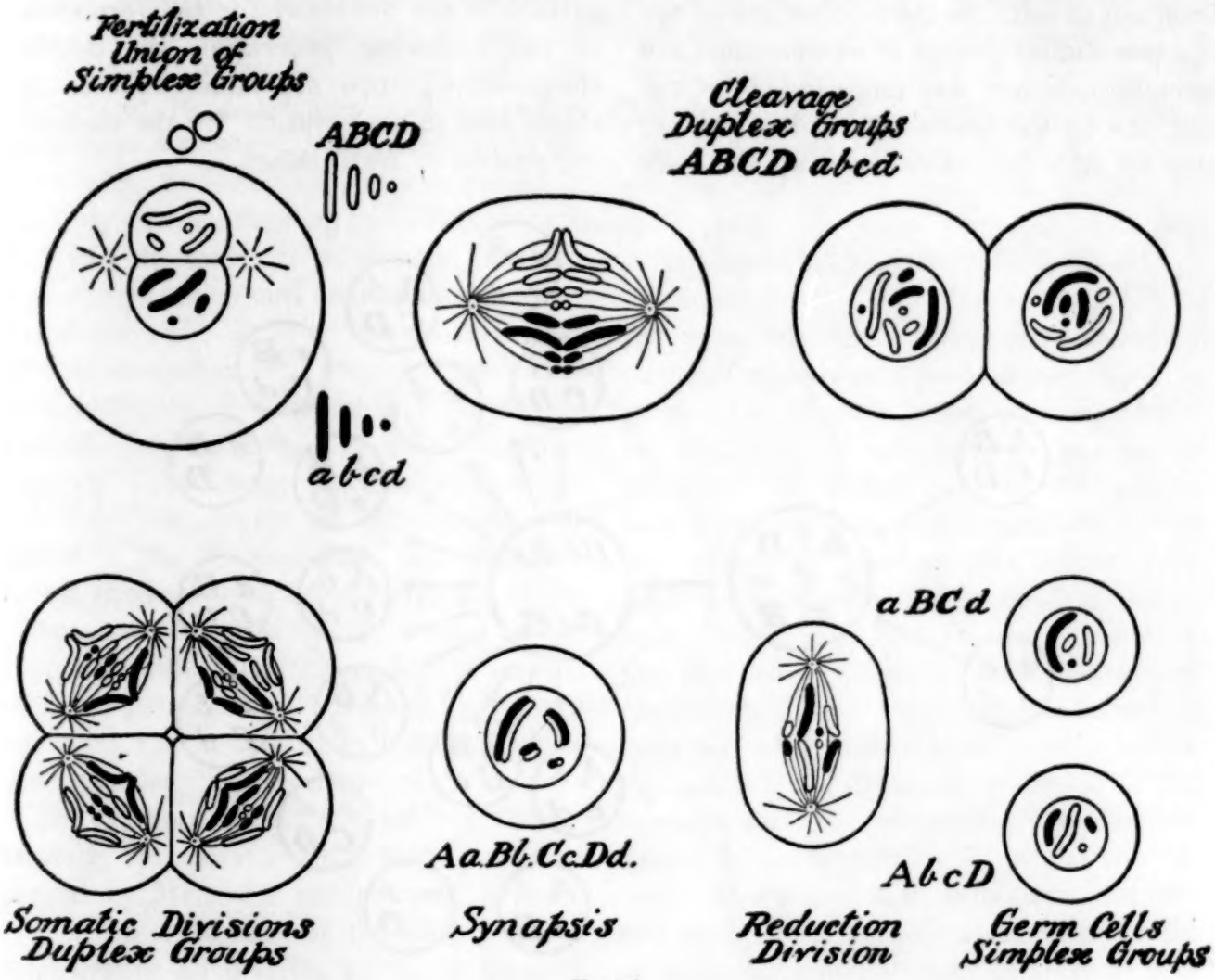

FIG. 1

With the aid of the accompanying diagram (Fig. 1) we may consider a few es-

sential facts concerning the chromosomes, leaving aside most of the complicated technical details. In each species of plant or animal the chromosomes are of constant, or nearly constant, number. They divide as the cell divides, and are thus transmitted from cell to cell. In the fertilization of the egg two similar groups of chromosomes are brought together, one contributed by the egg, one by the sperm-cell; and as the egg step by step divides to build up the body of the embryo the chromosomes also divide at each cell-division. Every cell-nucleus thus receives a double group of chromosomes, consisting of two single groups descended respectively from the two groups that originally came together in the fertilized egg. The two single groups of each nucleus are thus of maternal and of paternal ancestry, respectively. This all-important conclusion has been obstinately contested and is still denied by a few writers. I think, however, that all arguments against it must give way before the fact that in certain hybrids—in particular, certain fish-hybrids observed by Moenkhaus—the chromosomes of maternal ancestry can actually be distinguished by the eye from those of paternal. Finally, when new germ-cells are produced for the formation of the following generation the double chromosome-groups are again reduced to single ones in preparation for the succeeding process of fertilization.

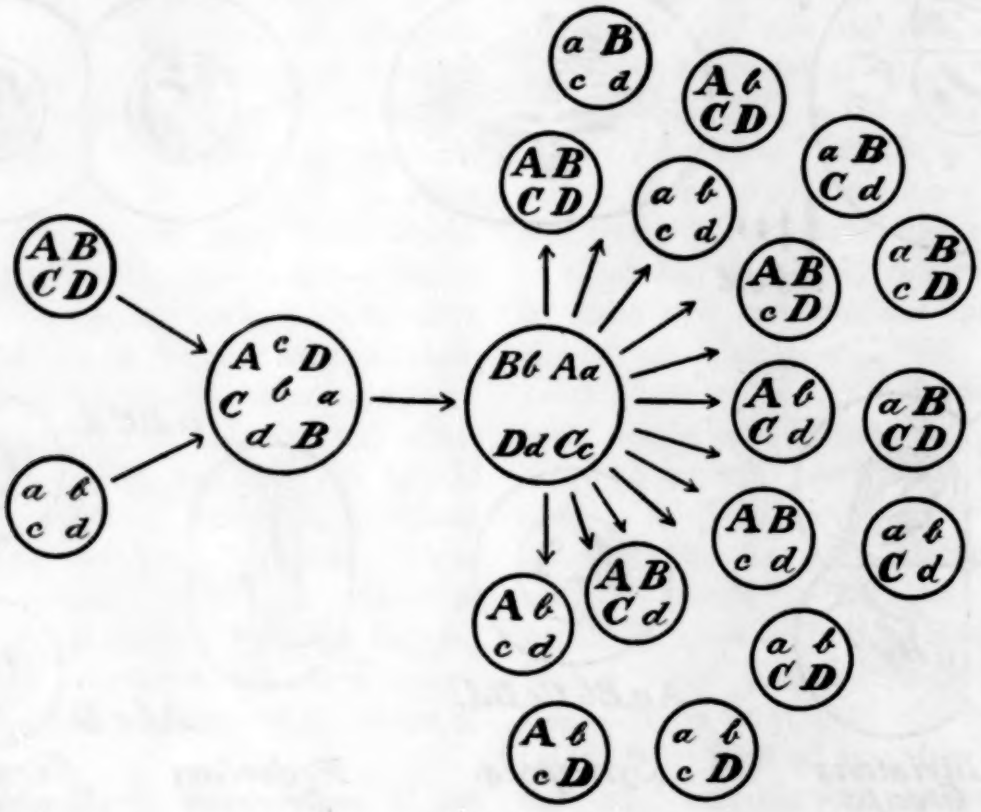

FIG. 2

These are not theories but observed facts. It is impossible to overlook the very precise parallel which they show to what Gregor Mendel and his successors have proved to be true also of the unit-characters, as will be made clear by the accompanying diagram (Fig. 2). When two similar or nearly similar individuals unite in fertilization they contribute to the germ two corresponding groups of unit-characters, which are designated in the diagram by two series of letters A–D and a–d, respectively. The

offspring are therefore of double or "duplex" hereditary constitution. When the germ-cells are formed, as Mendel first proved by experiments on hybrids, they are found to carry only a single or "simplex" group of characters. So closely parallel is all this to what we have learned about the chromosomes that we can just as well use the diagram for the chromosomes as for the characters. Chromosomes and characters alike form a single or simplex group in the germ-cells, a double or duplex group in the body of the offspring; and this alone is sufficient to make it extremely probable that chromosomes and characters are somehow connected. Exactly what is the nature of this connection we are not able to say with certainty; but we might reasonably assume, for instance, that each character depends upon some particular chemical substance, or group of substances, contained in the chromosomes, and that different chromosomes differ in respect to the substances which they carry. Such an assumption would be thoroughly in accord with the principles of chemical physiology and with the results of experiments upon the physiology of development.

The diagram brings out another fundamentally important fact that was also proved by Mendel's experiments, namely, that in the formation of the simplex character-groups all possible recombinations of the original parental unit-characters (within the limits of a single complete group) are effected. Only a few of the germ-cells receive the original combinations unchanged (A–D or a–d). In most cases new simplex groups are formed by recombination, such that each germ-cell receives always a complete single series (from A or a to D or d), but any particular member of the series may be derived from either parent. The number of such possible combinations varies, of course, with the simplex number of unit characters; with 4 characters, as in the present case, it is 16; with 15 characters it would be more than thirty thousand. Any individual may thus produce many different kinds of germ-cells, equivalent in a general way but differing slightly in respect to their individual hereditary components. This result follows from the fact, discovered by Mendel again, that corresponding or homologous parental components of the duplex groups (such as A and a, or B and b) never enter the same germ-cell; and this is the essential fact in "Mendel's Law." We could readily understand this if before the germ-cells are formed corresponding parental components become associated in pairs (Aa, Bb, etc.) and then separated or disjoined in an ensuing process of division. If the process of disjunction took place in each pair independently of the others, all combinations would obviously be produced in the resulting germ-cells. Now, it is certain that something like this actually takes place in the case of the chromosomes. In the process known as *synapsis*, which takes place shortly before the last two cell-divisions concerned in the formation of the germ-cells, the chromosomes do in fact unite in pairs, two by two. There is reason to believe that the two members of each pair are respectively of maternal and paternal derivation; and the probability of this view, first stated by Montgomery, has steadily increased. Observation has made it extremely probable that in the course of the following two divisions the two members of each pair, or two somethings that they contain, are separated so as to pass into different germ-cells (Fig. 1). One of the most interesting recent discoveries in cytology is the fact that in some animals and plants a paired arrangement of the chromosomes is assumed long before the period

of synapsis, and may even be seen more or less distinctly throughout the life of the organism.

As has been said, the remarkable parallel between chromosomes and unit-characters constitutes in itself strong (though indirect) evidence that the latter depend in some way upon the former. Specific experimental evidence directly demonstrates the correctness of this conclusion. If, for instance, the orderly distribution of the chromosomes in the fertilized egg is artificially interfered with (as may be done in several ways) the development of the embryo is correspondingly disturbed. Boveri has proved that when abnormal combinations of the chromosomes are thus produced in the fertilized eggs of sea-urchins the offspring are almost always abnormal, deformed or monstrous. Recent experimental studies have proved by various methods that certain interesting abnormalities shown in hybrids are preceded by corresponding disturbances in the chromosomes. Again, it is now possible to fertilize the eggs of such animals as sea-urchins by the spermatozoa of animals as widely different as worms or mollusks. The offspring of such "heterogeneous" crosses show only the characters of the mother. They are typical sea-urchin larvæ; and the explanation, demonstrated by microscopical observation, is that only the chromosomes of the mother are able to survive in the fertilized egg. Those of the foreign father (*i. e.*, of the sperm cell) sooner or later perish and degenerate within the egg.

Still another fact, of the same unmistakable import, is the recently demonstrated relation between the chromosomes and sex. Sex is now definitely known to be inherited like other characters; and within a few years the decisive proof has been attained that the heredity of sex is connected with a particular chromosome known as the "sex-chromosome" or "X-chromosome." In a large class of cases, to which man almost certainly belongs, the male contains but one of these chromosomes, the female two; hence in such cases the total number of chromosomes in the female is one greater than in the male. In respect to these particular chromosomes, accordingly, the male always remains of simplex composition (XO), while the female is of duplex (XX). Observation has proved further than when the duplex chromosome-group of the female are reduced to simplex ones each mature egg retains a single X-chromosome, while in the male only half the spermatozoa receive X and half do not. From this it follows that when the egg (X) is fertilized by a sperm-cell containing X the result is a female (XX), while if fertilized by a sperm-cell without X, the result is a male (XO). I shall try to show a little later how clearly and simply these facts explain certain very curious special phenomena connected with the heredity of sex.

The specific and direct evidence thus briefly outlined has definitely established the fact that the chromosomes are causal agents in heredity; and it has already become evident that the study of their modes of distribution, combination and recombination provides us with a key which will unlock many special puzzles of heredity which would otherwise seem to us insoluble. I will attempt to make this clear in greater detail by considering three of the particular cases that have already been touched upon, taking them up in the order of their difficulty.

The simplest of these cases is that of reversion, illustrated by the sweet peas. It is evident from the experimental results that the purple color of the flowers requires the cooperation of at least two things, either of which alone is unable to produce

any color. These two things may for the moment be called "A" and "B." Both A and B must obviously have been present in the original purple race from which the two white races are descended. One race has at some time in its past history lost A, the other B; and each loss has produced a specific type of white race which breeds true. By crossing the two A and B are again brought together, thus restoring the original combination AB; hence the "reversion" to the purple wild type. Now, the things which we have called "A" and "B" may very well be different chemical substances. If we assume them to be borne by different chromosomes, brought together in the hybrid, the whole matter becomes at once clear and simple. It seems probable that all kinds of reversion may be explained by the same principle.

The second case is that of "criss-cross" heredity in the short- and long-winged flies, where the sons are like their mother, the daughters like their father. The explanation of this case is less easy to follow than that of reversion, but is more specific. This case, and many others of similar type, may be completely explained through our knowledge of the relation of the chromosomes to sex. These flies agree with the general rule already referred to, that the males contain a single X-chromosome, or sex-chromosome, the females two. All the facts revealed by experiment are very simply and completely accounted for by the single assumption that the X-chromosome is responsible not only for sex, but also for the short-winged character. Specifically, the assumption is that the short wings are due to the lack or defect of something (let us again say some definite chemical substance) that is contained in the X-chromosome. Let us see just how this works out. We may write the formula for the short-winged female as *xx* (the small letters indicating the defect in *X* that is responsible for defective wing development), while that of the normal (long-winged) male is XO. Such a female produces eggs of only one type, *x*, while the normal male produces sperms of the two types X and no X or O. Fertilization thus can only give rise to the two combinations *x*X and *xO*, the former being females, the latter males. The males are short-winged because they contain only the defective *x*. The females likewise contain such an *x*, but they are nevertheless long-winged because they also contain a normal X, which is sufficient to ensure normal wing development. It follows that the daughters are long-winged like their father, the sons short-winged like their mother. I need not trace this explanation further into its details. It is enough to say that upon this one assumption the results of many other kinds of crosses among these flies work out perfectly; and a similar explanation will completely account for other cases of criss-cross fertilization, for such curious phenomena as the heredity of color-blindness in man, and many other cases in which particular somatic characters are linked with sex in a definite way. These cases offer, indeed, a brilliant example of the clearness and simplicity of the causal explanations that microscopical research has helped to give of complicated special phenomena of heredity.

As a third and last example I select an even more interesting and instructive case, the complete analysis of which carries us to the firing line of research in this field. It illustrates the influence of the grandparents upon the combinations of unit-characters seen in the grandchildren. It is a very curious fact, only recently discovered, that in certain cases hybrids of identical composition exhibit marked differences in their output of offspring that can

only be explained by an exact knowledge of the grandparents. We have already seen a concrete example of this; but before returning to it the essential result may be explained by means of a diagram. Let us consider the case of a hybrid that contains four characters, which we will designate as A, a, B and b. The hybrid AaBb can be made in two ways, according to the composition of the parents. First, one parent may contribute AB and the other ab; or, secondly, one parent may contribute Ab and the other aB. These two crosses seem to give precisely the same result, AaBb. The hybrids produced by the two methods look exactly alike; they produce the same kind of offspring (grandchildren of the original forms). The remarkable fact is, however, that in some cases (probably in many) the offspring of the two kinds of hybrids differ in respect to the numerical proportions in which different combinations of the grandparental characters appear. In both cases the grandchildren are of four visibly different types, AB, aB, Ab and ab. Following the first cross, however (AB $\times$ ab), the classes AB and ab are in great excess among the grandchildren, sometimes in very great excess; while following the second cross (Ab $\times$ aB) it is the classes Ab and aB that are in excess. In other words, in each case a large majority of the grandchildren are of the same type as their grandparents, while a small minority show new combinations of the grandparental characters. To change the statement, if A and B enter the hybrid together they tend to come out together in the grandchildren; if they enter separately they tend to come out separately. Why should this be so?

The facts will become clearer if we look again at the actual case of the fruit-flies already referred to, which was worked out by Professor Morgan. The grandfather combines white eyes and yellow body color; the grandmother red eyes and gray color. White eyes and yellow color here enter the hybrid together, while white eyes and gray color, or red eyes and yellow color enter separately. The hybrids in the first generation all show red eyes and gray color, like the mother. On pairing the hybrids together, all four combinations appear—red eye and gray color, white eye and yellow color, white eye and gray color and red eye and yellow. The last three of these are *seen* only among the males; for although also present among the females they do not come into actual view, because in this sex white eye or yellow color is dominated or concealed by red eye or gray color. We may therefore confine our attention to the males. Now, on counting the relative numbers of these types among the grandsons a remarkable result constantly appears. An enormous majority of them—more than 100 to 1—show the same combinations as the grandparents, namely, white eye and yellow color, or red eye and gray color; while the two new combinations, white eye and gray color, and red eye and yellow color, are correspondingly rare. This, I repeat, is obviously because the characters that enter the hybrid together tend to come out together in the grandchildren; those that enter separately tend to come out separately. This at once suggests that the difference of result depends upon whether the two characters in question are borne by a common carrier in the germ-cells or by different carriers. White eye and yellow color tend to hold together because they enter the hybrid in some common carrier. White eye and gray color, or red eye and yellow color tend to remain separate because they enter the hybrid in different carriers. What are these carriers? Very extended experiments, analogous to that just de-

scribed, and involving the breeding of many thousands of these flies, have steadily increased the probability that these carriers are nothing other than the chromosomes. These experiments make it almost certain that in the cross we have been considering white eyes and yellow color are alike determined by the same chromosome, while red eyes and yellow color must obviously have been carried originally by different chromosomes, since they came from different grandparents.

There is here, as in the case of the short-winged flies, almost conclusive proof that a single chromosome may be responsible for the heredity of more than one character; and experiments of the same type have proved that a single chromosome may be responsible for many characters—at least twenty, and probably many more. Independent microscopical investigation has provided a very definite basis for this conclusion, having made it almost certain that the chromosome is a compound body, which includes many smaller elements, perhaps different chemical substances, each of which may play a definite part in determination. Both kinds of evidence indicate that these different elements are arranged in the chromosomes in linear series and in a definite way. The chromosomes arise from long threads, which split lengthwise throughout their whole length during division. In this way all the separate elements or substances which they contain may be equally divided and distributed to the daughter cells.

And this leads us finally to one more point that now forms a center of interest in these studies. Although (in such cases as we have been considering) characters that enter the hybrid together tend to come out together in the grandchildren, they do not always do so. As we have seen, in a few of the grandchildren characters that were originally associated have separated so as to produce new combinations—such, for example, as the white-eyed gray flies, or the red-eyed yellows. How can this be reconciled with the conclusion that they were originally borne by the same chromosome? A possible answer to this question has been offered by Janssens's theory of the "chiasmatype," which has been more specifically and very ingeniously worked out by Morgan and some of his pupils. Reference has already been made to the fact that at a certain period, shortly before the germ-cells are formed, corresponding maternal and paternal chromosomes become coupled in pairs, side by side (synapsis). This process is always followed by a more or less intimate union of the two threads, perhaps in some cases by actual fusion. The evidence is still more or less conflicting as to exactly what follows; but it is certain that at a later period two separate and parallel threads again become distinct, and these *may* separate so as to pass unchanged into different germ-cells. These two threads are believed by many observers to be identical with those that originally united in synapsis, but this is in dispute. The fact of particular interest in this connection is that the two threads often become twisted around each other like the strands of a rope; and the observations of Janssens indicate that in some cases these threads may fuse at certain points where they cross and then split apart at these points in the longitudinal plane. By this process, as will be made clear by the accompanying diagram (Fig. 3), the possibility is given of an *orderly* exchange of certain regions of the threads between the two chromosomes of each pair. Now, it has been suggested that in this way two chromosomes that originally carry (let us say) AB and ab, may undergo such an exchange as to produce the new chromo-

somes Ab and aB, as shown in the upper part of the diagram. If this should happen only occasionally it would fully explain how it is that two characters borne by the same chromosome tend to remain together,

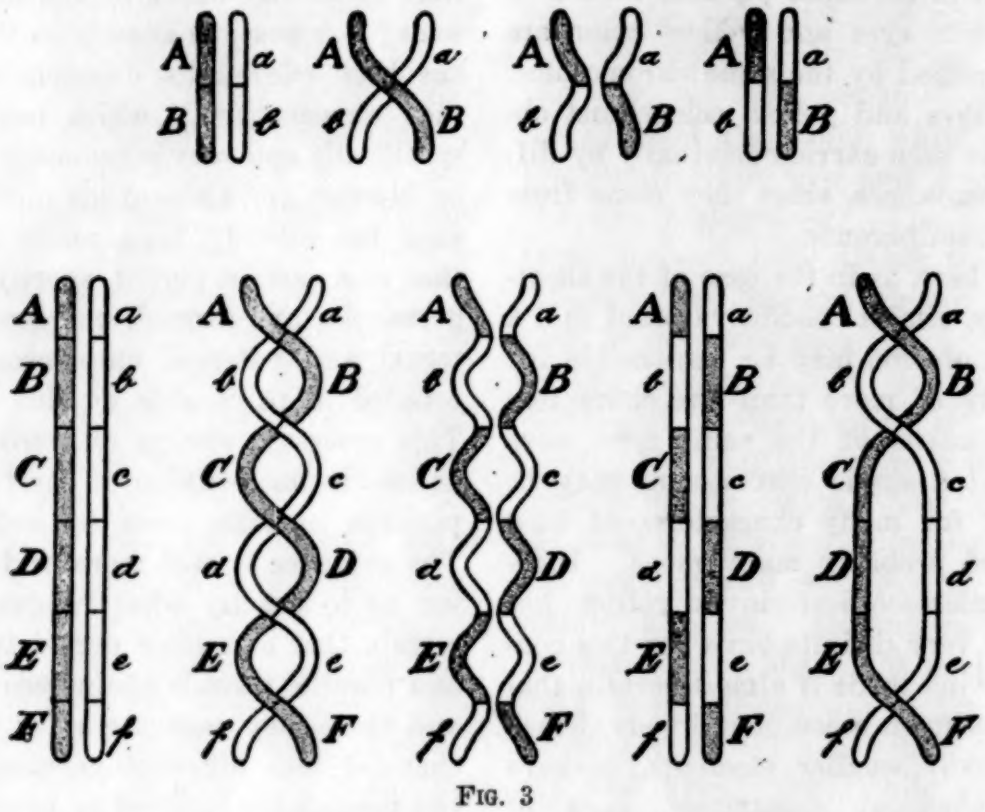

Fig. 3

yet *may* separate so as to pass into different chromosomes and hence into different germ-cells. As shown in the lower part of the diagram, a similar explanation may be extended to much larger series of characters, the behavior of which in detail may depend upon their arrangement in the threads, or on the character of the twisting. On the basis of this hypothesis an attempt has recently been made by Sturtevant to calculate from the observed results the degree and character of the twisting of the chromosomes, and the relative position of the different specific elements within them. This, admittedly, is a bold venture into a highly hypothetical region. Its justification is the pragmatic one that it "works." The hypothesis gives us the only intelligible explanation that has yet been offered of a series of undoubted facts; and it is certainly worthy of the most attentive further examination.

The three cases that have been considered have led us, step by step, to the border line of research in this field. I have not hesitated, in discussing the last case, to advance beyond the solid ground of observed fact into a debatable and hypothetical region; for it is by just such venturesome advances that new possibilities of discovery are opened. We have much to gain and nothing to lose by the use of explanatory hypotheses that are naturally suggested by the facts and help us to formulate them for analysis, so long as such hypotheses are not allowed to degenerate into dogmas accepted as an act of faith, but are only used as instruments for further observation and experiment. The "chiasmatype" hypothesis is no more than this; and though it is directly suggested by observed facts it remains for the present unproved. The more general conclusions that have been indi-

cated regarding the chromosomes stand, however, upon much firmer ground. That the chromosomes are in fact causal agents in determination can now be doubted, so I think, only by those who refuse to reckon squarely with the whole body of evidence. That the distribution of the chromosomes, or of smaller elements that they contain, gives us at least a partial explanation of the behavior of unit-characters has become in a high degree probable. The stubbornness with which each step in the establishment of these conclusions has been contested has been largely due, I think, to a misapprehension for which the advocates of the chromosome-theory are themselves in part responsible. The chromosomes have often been spoken of as if they were central, controlling factors in heredity, or as if they were actual bearers of the unit-characters—the latter form of expression has in fact been employed, for the sake of brevity, in the foregoing discussion. But it seems to me that such expressions are, to say the least, misleading; they are certainly unnecessary. It is perfectly obvious that chromosomes do not bear hereditary characters as such; they bear only *somethings* that are necessary to the production of characters. I again repeat that these "somethings" may be at bottom of chemical nature. We find it convenient, in order to avoid circumlocution, to speak of these things or substances as "determiners"; and there is no objection to doing this so long as we do not forget that many other things are concerned in the production of every character. Experiment has made it certain that the cell protoplasm is thus concerned. It is possible that the chondriosomes or plastosomes may here play an important part. In any case, the conclusion is not to be escaped, I think, that the whole cell-system is directly or indirectly involved in the production of every hereditary trait. To treat the chromosomes as if they were central governing or controlling factors in the cell is a procedure of more than doubtful expediency. For the present, at least, all the requirements of investigation are sufficiently met if we think of the chromosomes, or that which they carry, only as *differential factors* in heredity, not as its primary or exclusive "determiners." Whether they possess a significance more fundamental than this is a question that may well await the results of further inquiry.

I can refer here to only one or two of the many disputed questions of detail regarding the chromosomes. One of the most important is whether the chromosomes retain their individuality intact in the nuclei of the "resting period" or interkinesis that intervenes between successive cell-divisions. Some of the most careful recent cytological studies in this direction seem to show that such is not the case. Nevertheless these same studies, together with recent experimental evidence, give very strong ground for the conclusion that a definite relation of genetic continuity exists between the individual chromosomes of successive generations of cells. On the one hand, the cytological studies of Boveri, Bonnevie, Vejdovsky and others, almost conclusively prove in certain cases that each chromosome is formed directly from the substance of a corresponding chromosome in the preceding generation. On the other hand, cytological and experimental evidence combine to show that alterations of the chromosome-groups, involving the addition to or subtraction from the group of one or more *particular chromosomes,* are perpetuated generation after generation of cells, even throughout the life of the individual. Nature performs such an experiment every day in the production of sex; for the particular chromosome-com-

binations established by the entrance into the eggs of spermatozoa with or without the X-chromosome persist throughout the whole development of the individual until new germ-cells are formed.

A second fundamentally important question, concerning which no general consensus of cytologists has yet been reached, relates to the mode of union of the chromosomes in synapsis and the subsequent distribution of their substance to the germ-cells. Only in a few special cases has complete proof been attained of a conjugation followed by complete disjunction or separation of the original conjugating chromosomes. Until this complicated and difficult problem has been much more thoroughly studied we shall not be in a position to explain exactly what is the mechanism of Mendel's law of heredity and the distribution of the unit-factors to the germ-cells. We are not dealing with a closed chapter in the study of heredity. Both genetic and microscopical research are still in a formative stage. It is hardly a decade since they finally converged upon the same specific problems. We must not yet make too exacting a demand upon the explanatory capacity of either; and it is a part of the present interest of the subject that so much still remains to be accomplished.

We have thus arrived at some of the most advanced and difficult questions in this field of inquiry. Perhaps I have not succeeded in making entirely clear even the few illustrative cases that have been considered. If so, I must plead in extenuation that the subject is beset with technical difficulties; and we biological folk have come to speak a language that is strange to many of our fellows. But I have been less concerned with the presentation of particular results or the critical discussion of details than with the indication of a point of view; I have only wished to point out one of the pathways along which students of cytology are attempting to cooperate with students of genetics in their attack upon the problems of heredity. I would like to urge in closing that such explanations as have here been briefly indicated are not mere vague and general notions. They are specific and detailed interpretations of observed facts. They enable us, up to a certain point, to comprehend what goes on in the germ-cells, to form perfectly clear mental pictures of the apparatus of heredity, and of its mode of action in particular cases. They contain no mystical or transcendental element. I repeat that they are entirely in accord with the principles of chemical physiology, and with the experimental results upon the physiology of development. To this extent at least the explanations are real and represent a partial solution of the problem of heredity. No one would maintain that these explanations are final. I do not doubt that with advancing knowledge we shall in time come to look back upon many of our present conceptions as crude and naïve. Discovery in this great field of research has made no approach to its limit. Great progress in the future is certain. But if you ask whether we may hope to reach at last a complete or final solution of the problem of heredity, I fear the answer must be, no. The man of science should be the first to admit that science can not attain to a complete understanding of anything. The explanation of any phenomenon only uncovers new phenomena behind it that still demand explanation, in endless succession; and such is the essential characteristic of scientific progress. Science does not aim at ultimate explanations; and could we find them, science would be emptied of its interest to the investigator.

Edmund B. Wilson

Columbia University

CHANCELLOR JORDAN AND PRESIDENT BRANNER

AT the commencement of Leland Stanford Junior University on May 19 Dr. David Starr Jordan made a statement as follows:

I wish at this time to make a personal statement. In the interest of larger duties toward the university and toward the public, I have expressed to the board of trustees the wish to be relieved so far as may be from routine duties of the presidency.

In appreciation of this wish, and for the expressed purpose of allowing me "to represent more fully the university in its functions toward the public, and the relations of the university to educational agencies outside the university itself," the board of trustees at its meeting on May 23 will create the new office of chancellor of the university.

The position of president will be filled by Dr. John Casper Branner, my intimate friend for forty-three years, my academic colleague for twenty-nine years, and, as vice-president of the university for fifteen years, my closest administrative associate.

In accepting the chancellorship, and withdrawing from the immediate direction of administrative affairs, I shall abate no part of my interest in the university to which I have given the best years of my life, and to which I hope the best that remains will also be dedicated.

In placing the immediate control in the hands of one of the ablest of American scholars, one of the most successful of teachers and most loyal of men, I am sure that the board of trustees has made no mistake. So long as Dr. Branner shall direct its affairs the university will continue to develop the highest purposes of its founders, and of our colleagues, who, through twenty-two eventful years, have maintained and carried forward its standards and ideals.

Dr. J. M. Stillman then made the following statement:

With the consent of the president and at the request of members of the board of trustees, I am to speak a word of appreciation and welcome to President Jordan on assuming the new dignity of the chancellorship of the university.

The creation of this office has had two purposes: First—the division between the offices of chancellor and president of the burden of administrative duties and responsibilities hitherto vested solely in the president, and which the development of the modern university has made increasingly laborious and onerous. Second—in high appreciation of the great service President Jordan has rendered and is rendering, not merely to this university, but to the world's work in the cause of education, science and civilization, it is intended that the institution of this new office shall, by thus relieving him of much of the routine of executive work, enable him to devote his attention in increasing measure to the greater problems within and without the university.

For twenty-two years President Jordan has been the inspiration of Stanford University. What it is is due mainly to his high ideals, his breadth of outlook and warmth of sympathy. These qualities and abilities the university needs in the future as in the past, and these the office of chancellor ensures us. Trustees and faculty, alumni and students, will continue to profit by his wisdom and his enthusiasms. But it is also recognized that the world at large has a claim upon his abilities which it should be the mission of Stanford to further and to encourage.

In the belief that the division of administrative functions between two such cooperative and sympathetic leaders as Chancellor Jordan and President Branner, will promote the efficiency, usefulness and influence of the university, and that under their joint guidance the aims and ideals of Stanford University will be carried forward to greater and grander development, I venture to assume that I express the sentiment of the whole university community in extending to Chancellor Jordan our congratulations upon his well-deserved and welcome respite from a large share of administrative detail, and upon his increased opportunities for the highest service not only to this his university, but to the wider world beyond its gates.

THE PENSION PLAN OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FOR a long time the trustees of the American Museum of Natural History have had under consideration a plan for adequately providing for employees who were of mature age or who had been long in the service, and who through their efficiency and faithfulness were entitled to some recognition. A plan was finally worked out by a committee of trustees and a committee of employees and was adopted by the trustees at the annual meeting in Feb-

ruary. The plan went into effect on March 1, 1913.

The plan is similar to those in successful operation in many great manufacturing corporations in the United States. It is a contributory system, the subscribing employees contributing 3 per cent. of their salaries, and the trustees contributing an equal amount to the fund.

The plan already briefly noted in Science provides:

1. Pensions.—Six classes of pensions according to length of service and age, the pensions varying from 25 per cent. to 50 per cent. of the average salary of the last three years.

2. Health Insurance.—Gratuity to the employee in case he is totally disabled through illness, or his position is abolished.

3. Life Insurance.—A gratuity to a beneficiary, in the event of the death of the employee, and under certain conditions in the event of the death of a pensioner.

4. For the return of the employee's contribution with simple interest at 3 per cent. in case the employee leaves the service of the museum before he is eligible for a pension.

The plan also makes provision for exceptional cases; leave of absence without pay; absence from the service for a certain period; return to the service; reduction of present rate of contribution when feasible, and for the amendment or alteration of the plan as circumstances may warrant in the future.

SCIENTIFIC NOTES AND NEWS

At the annual meeting of the American Academy of Arts and Sciences held on May 14 last, it was voted to award the Rumford Premium to Professor Joel Stebbins, of the University of Illinois, for his development of the selenium photometer and its application to astronomical problems.

The gold medal of the Swiss Geographical Society will be presented to Admiral Peary at a banquet to be given at Geneva, on May 31.

Dr. Alfred H. Brooks, of the U. S. Geological Survey, has been awarded the Conrad Maltebrun gold medal of the Paris Geographical Society.

In appreciation of his services in reestablishing the American Rainbow trout in Germany, Dr. Hugh M. Smith, United States Commissioner of Fisheries, has been presented with a medal by the German Fishery Society.

Dr. Henry S. Carhart, emeritus professor of physics in the University of Michigan, and Professor F. R. Moulton, professor of astronomy in the University of Chicago, have been made honorary corresponding members of the British Association for the Advancement of Science.

Professor Hermann von Vöchting has been elected a foreign member of the Linnean Society, London.

Dr. Gisbert Kapp, professor of electrical engineering in the University of Birmingham, has been appointed president of Section G (engineering) of the British Association for the meeting to be held in Birmingham in September next.

Announcement is made at the University of Chicago of the joint award to Dr. George L. Kite and Mr. Esmond R. Long, graduate students in the department of pathology and bacteriology, of the Howard Taylor Ricketts prize of $250 for original research in that department. The prize was established by the widow of Dr. Ricketts, who died in the City of Mexico from typhus fever contracted while studying the disease.

The committee on medical research of the American Medical Association has awarded a grant of two hundred and fifty dollars to the department of bacteriology of the Hoagland Laboratory, Brooklyn, to defray the expenses of an investigation on the immunity reactions of edestin, a report of which is shortly to appear in the *Journal of Infectious Diseases*.

Among American astronomers who expect to attend the meeting of the International Solar Union to be held at Bonn, Germany, in August next, are Professors E. C. Pickering, Harvard College Observatory; Frank Schlesinger, Allegheny Observatory; J. A. Parkhurst, Yerkes Observatory; C. E. St. John,

Mount Wilson; H. N. Russell, Princeton, and J. S. Plaskett, Ottawa.

MR. EDWIN HATFIELD ANDERSON has been promoted to be director of the New York Public Library, succeeding the late Dr. John S. Billings.

C. S. RIDGWAY, assistant professor of botany at the Alabama Polytechnic Institute, Auburn, Ala., has resigned in order to accept an appointment in the Bureau of Plant Industry at Washington.

MR. LLOYD B. SMITH, professor of geology in the Carnegie Institute of Technology of Pittsburgh, Pa., has resigned to enter the employ of the Associated Geological Engineers in the examination of oil and gas properties.

DR. KARL GEISER, head of the department of political science in Oberlin College, will spend the summer in Germany investigating rural problems with special attention to rural local government.

A BIOLOGICAL expedition is being sent out by the University of the Philippines and the Bureau of Science. It started from Manila on April 5 for Taytay Bay on the northeastern coast of the Island of Palawan, and will remain in the field for two months. The party will consist of Dr. Merrill, chief of the division of botany of the Bureau of Science, Mr. Schultze, entomologist of the Bureau of Science; Mr. Rowley, instructor in geology, of the University of the Philippines; Messrs. Griffin, Cowles, Wharton, Day and Light, of the department of zoology of the university, and Mr. Barnes, teacher of zoology of the Bureau of Education. Including the assistants and laborers, the working party will consist of about twenty-five persons. The expedition will be under the direction of Professor Griffin. The region to which the party goes is entirely unexplored, but is said to be extremely rich in its fauna and flora.

AT the annual general meeting of the Institution of Civil Engineers, held in London on April 29, the result of the ballot for the election of officers was declared as follows: *President,* A. G. Lyster; *Vice-presidents,* B. H. Blyth, J. Strain, G. R. Jebb, A. Ross; *other Members of Council,* J. A. F. Aspinall, J. A. Brodie, W. B. Bryan, Col. R. E. B. Crompton, C.B., J. M. Dobson, Sir H. F. Donaldson, K.C.B., E. B. Ellington, W. H. Ellis, W. Ferguson, Sir Maurice Mitzmaurice, C.M.G., Sir J. P. Griffith, Dr. C. A. Harrison, W. Hunter, H. E. Jones, Sir Thomas Matthews, Dr. W. H. Maw, C. L. Morgan, B. Mott, A. M. Tippett, Sir Philip Watts, K.C.B., W. B. Worthington, Dr. Dugald Clerk, F.R.S., R. S. Highet, Dr. E. Hopkinson, F. Palmer and H. N. Ruttan.

THE special faculty committee from the University of Wisconsin appointed by President Charles R. Van Hise to receive and provide entertainment for the party of over 100 citizens of Pennsylvania, Maryland and Connecticut who spent the four days between May 21 and May 24, inclusive, inspecting the University of Wisconsin consisted of the following men: Professor L. E. Reber, dean of the Extension Division; Professor J. G. D. Mach, representing the College of Engineering; Frank Barron Morrison, representing the College of Agriculture; Professor Julius E. Olson, of the Scandinavian Department; Professor Ralph Starr Butler, of the Extension Division; W. H. Lighty, secretary of the Extension Division; Professor Dana C. Munro, head of the History Department; Professor George C. Comstock, head of the Astronomy Department; Dr. Hermon C. Bumpus, business manager of the university; Professor Scott H. Goodnight, of the German Department, and Professor E. A. Ross, head of the Department of Sociology.

PROFESSOR HENRY L. BOLLEY, head of the botany department at North Dakota Agricultural College, gave a public lecture at the College of Agriculture of the University of Wisconsin this week, in which he explained his theory for crop failure which results when cereal grains are planted in the same fields for several years. It was argued that the failure of the crop is not due to exhaustion of the soil fertility, but to the accumulation of soil parasites which are poisonous to the cereal grains.

Professor Julius Stieglitz, of the University of Chicago, lectured on May 21 at the University of Illinois on "Combustion, or the Electric Theory of Oxidation."

Dr. Frank Schlesinger, director of the Allegheny Observatory, delivered a lecture on "Astronomical Photography" before the Royal Astronomical Society of Canada, at Ottawa, on April 22 and at Toronto University on April 24.

The Bakerian lecture of the Royal Society was delivered by Sir J. J. Thomson on May 22, the subject being "Rays of Positive Electricity."

The first Wilbur Wright memorial lecture was delivered by Mr. Horace Darwin, F.R.S., at the Royal United Service Institution on May 21, under the auspices of the Aeronautical Society, which has raised a fund for the annual delivery of a lecture to commemorate the work of Wilbur Wright.

Addison Brown, ex-judge of the United States Court, for many years a member of the New York Academy of Sciences, a fellow and a patron, died at his residence in New York City on April 9, 1913, in the eighty-fourth year of his age. Judge Brown's favorite studies were botany and horticulture, but he also took great interest in astronomy. He was a member and benefactor of the New York Botanical Garden, one of its original incorporators, and, at the time of his death, its president. The council of the New York Academy of Sciences has passed a resolution, drawn up by a committee consisting of N. L. Britton, J. J. Stevenson and E. O. Hovey, which reads as follows:

> Whereas, The council of the New York Academy of Sciences has learned of the death of Ex-Judge Addison Brown, who for many years has been active in promoting the welfare of botany and its related sciences in this city,
>
> *Resolved:* That the council appreciates his services to science, and mourns his loss; that the above memorial and preamble be entered on the minutes of the council and a copy be sent to his bereaved family.

Dr. William Hallock, professor of physics in Columbia University since 1892, known for his researches in physics and for his interest in educational and scientific organization, died on May 20, aged fifty-six years.

Dr. William McMurtrie, one of the leading industrial chemists of the United States, formerly chief chemist of the Department of Agriculture and professor of chemistry in the University of Illinois, died on May 24, aged sixty-two years.

Dr. Ernest Kittl, director of the Royal Natural History Museum at Vienna, professor in the Vienna Institute of Technology, known for his contributions to geology, died on May 1, in his fifty-ninth year.

The U. S. Civil Service Commission announces an examination for electro-metallurgist on June 18, 1913, to fill a vacancy in the Bureau of Mines, Department of the Interior, for service in the field, at a salary ranging from $1,500 to $1,800 a year.

The Newcastle city council has decided to invite the British Association to meet in Newcastle in 1916.

The Minister of the Interior of the Canadian government has authorized the purchase and installation of a reflecting telescope of not less than sixty inches aperture for the Dominion Observatory. The telescope will probably be erected at a suitable site in the Canadian Rockies.

The legislature of California has passed a bill, drawn by Dr. Charles L. Edwards and introduced in the assembly by Mr. Frank H. Mouser, providing for a survey of the coastal waters preliminary to the establishment of a legally protected aquaculture. It is intended to divide the California coast into from three to five districts within which a considerable number of perpetual reservations will be formed for the natural and artificial propagation of animals and plants inhabiting the sea. The law will provide for leasing of sea farms and the patrol and protection of the coastal waters. The survey is placed under the Scripps Institute of Biological Research of which Dr. W. E. Ritter is director. A report is to be made to the governor on or before November 1, 1914.

THE United States Geological Survey had another close call on Sunday, May 18, in a destructive fire that practically gutted the basement of the entire building which it occupies. Owing to the congested condition of the store rooms and document rooms and to the escape of gas, the fire proved to be most stubborn and difficult to handle and resulted in the collapse of some 20 firemen, among them the chief of the Washington fire department. There was little flame, but the smoke poured in dense volumes from the Survey building, suffocating the firemen, who, however, fought desperately to keep the fire confined within the basement. The chief of the fire department states that had it got past the staircase which the men were holding and into the elevator shafts probably the entire building and possibly other adjacent buildings would have been consumed. The destruction, as it was, resulted in a loss of about $75,000, mostly in topographic maps, geologic folios, and reports, which, however, can be replaced. The unpublished data and other material in the upper floors of the building, having an estimated value between four and a half and five million dollars, were fortunately unharmed. "The only thing that saved the rest of the survey building from total destruction," said Director Smith in an interview, "was the efficiency of the Washington fire department, aided as it was by some fireproof doors leading from the basement to the upper hall, which had been erected on the recommendations of the chief of the fire department and the fire marshal. In its present quarters, after installing every possible safeguard, it appears that the government must rely upon the bravery and efficiency of the Washington fire department." The survey's campaign of last winter resulted in the authorization by congress of a new survey building to cost $2,596,000, but work on it can not begin until the money is made available in the next appropriation bill. Then, according to the usual time required in the construction of government buildings, it will be from three to four years before the survey can get out of its present quarters.

As a result of the fire in the Geological Survey building the director has announced a "fire sale" of geologic folios. The entire basement, in which the folios were stored, was filled with dense smoke and many of the folios were burned, others scorched, and all more or less damaged by water. With the approval of Secretary Lane the director announces that he will sell the entire remaining stock of some 150,000 folios, four fifths of which are probably as near perfect as goods usually offered in a smoke or fire sale, at the nominal price of 5 cents each. The regular retail price of the standard folios is 25 cents, but a few unusually large folios have sold for 50 cents, and the regular price of the "field edition" of the later folios, a more convenient form for use in the field, is 50 cents. All these are now to be had at 5 cents each, but no wholesale rate applies. The stock includes probably 50,000 to 100,000 copies on which the real damage is practically negligible. Application should be made to the director, U. S. Geological Survey, Washington, D. C., and remittance made by money order or in coin. Lists will be sent on application.

AN exhibition by the Pennsylvania Forestry Association was held in Horticultural Hall, Philadelphia, May 19 to 24. The association had arranged to make this exhibition as comprehensive as possible and, to that end, had included specimens of various woods, barks, leaves, seeds and other indicative features, growing seedlings, forest animals, fish, birds and insects of Pennsylvania, uses of lumber, wood preservation, wood substitutes, utilization of waste forest products. Exhibits were received from: Pennsylvania Department of Forestry, Chestnut Tree Blight Commission, Pennsylvania Fish Protective Association, Lumberman's Exchange of the City of Philadelphia, Pennsylvania State College, Pennsylvania State Museum, University of Pennsylvania, U. S. Forest Service, and a number of important associations or corporations interested in forest preservation, lumber production, etc. A series of addresses (some liberally illustrated) was given by men prom-

inent in the field of forestry, in the afternoons and evenings of the week.

The Wistar Institute in Philadelphia is remodeling a building 90′ × 31′, three stories in height, to be used for an animal house. The first floor and basement are to be entirely of iron and concrete construction with rooms varying in temperature and light according to the requirements of the colony. The building will have space sufficient for 1,000 cages, and will be equipped with steam heat, electric lights and hot and cold water. A covered passageway will connect it with the present museum and laboratory building. The building will contain a balance room where accurate weights and measurements may be taken. The necessary apparatus for the preparation of food and a crematory for the disposition of waste material and the heating of water will be installed. The building will furnish more ample space for the work in progress and give opportunities for extending the experimental work with animals. The colonies of white rats and opossums will be transferred from the laboratory building and the farm in New Jersey to this building as soon as it is ready.

A hundred new maps a year are the product of the big engraving and printing plant of the United States Geological Survey at Washington. About two atlas sheets a week are turned out in the construction of the great topographic map of the United States. The 15 new sheets added during the last six weeks to the 2,200 now carried in the regular stock show good examples of the widely different kinds of country covered by the government topographers. The areas mapped on these sheets range from the high forested mountain region of Colorado to the low, rich alluvial bottom lands of Mississippi and Louisiana—lands valuable for mineral resources, and lands rich in agricultural possibilities beyond the dreams of avarice. For any comprehensive development of these areas the topographic base map becomes the first engineering necessity. The scale of the maps varies from 1 inch on the paper, representing half a mile of country, with a contour interval of only 5 feet, for the Mississippi delta lands —showing a very detailed survey suitable for a drainage base—to 1 inch representing 2 miles, with 100-foot contours, for the Castle Rock quadrangle, Colorado—covering an area which does not require such refined work. The Castle Rock area contains coal and lignite and a report on it will be made later by the survey in the form of a geologic folio; but the vicinity of Castle Rock is also famous for its potatoes, which are comparable to the famous Greeley potatoes, and for other agricultural products. The western portion of the area includes part of the Pike National Forest, and for national forest administration the map affords an ideal base. Three of the maps represent lands along Mississippi River in the Yazoo Delta; they show parts of the Moon Lake quadrangle, the Hollywood (Tunica County) quadrangle and the Lake Cormorant quadrangle, all in Mississippi. These maps were made in cooperation between the Federal Survey and the Tallahatchie Drainage Commission of the state of Mississippi. They are on the scale of 1 inch to half a mile, with 5-foot contour intervals, and show every slough and swampy place and every inequality of the area which must be taken into consideration in planning a drainage system that shall make these lands the most productive in the United States. Farther down the river, in Louisiana, similar areas have been mapped in cooperation between the Federal Survey and the Fifth Louisiana Levee District of the state of Louisiana, the sheets portraying portions of three quadrangles, the Ashton Bridge, Millikin and Millikens Bend—land built from the silt brought down by the great river and of nearly inexhaustible fertility. Another map of an area cut by the course of the Mississippi—the Milan quadrangle, Illinois—shows country of a different character. Here at Rock Island the Father of Waters is less of a problem. This map was made in cooperation between the Federal Survey and the state geologist of Illinois. The scale of this map is 1 mile to 1 inch and the contour interval 20 feet. A still different contour interval—50 feet—is that of the map showing the Salinas quadrangle, in Monterey County, California, where the work was done in coopera-

tion between the Federal Survey and the state of California.

WE learn from *Nature* that it is proposed to celebrate the centenary of the foundation of the Indian Museum in Calcutta next February. Originally founded as a branch of the Asiatic Society of Bengal at the suggestion of Wallich, the botanist, on February 2, 1814, the Indian Museum became a government institution in 1867, after prolonged negotiations with the government of India, which accepted the society's collections to form the nucleus of an imperial museum in Calcutta. A centenary committee has been formed with Lord Carmichael, the governor of Bengal, as chairman, and Sir Asutosh, Mookerjee, vice-chancellor of the Calcutta University, as vice-chairman. The committee has decided to publish an official history of the museum, to raise a special fund for the improvement of the public galleries, and to hold a reception in the museum on the anniversary of its foundation.

UNIVERSITY AND EDUCATIONAL NEWS

THE General Education Board at its May meeting made appropriations of $837,600. Conditional appropriations for colleges are as follows:

John B. Stetson University, Deland, Fla.	$ 50,000
Northwestern University, Evanston, Ill.	100,000
Pomona College, Claremont, Cal.	150,000
Union College, Schenectady, N. Y.	75,000
Williams College, Williamstown, Mass	100,000

Appropriations for special purposes are as follows:

For demonstration work in agriculture in the southern states, which include the boys' corn club work	180,050
For the promotion of girls' canning and poultry clubs throughout the south	75,000
For agricultural demonstration work in five counties of Maine	14,500
For the beginning of agricultural demonstration work in New Hampshire	7,500
For professors of secondary education in the several state universities of the southern states	30,550
For state supervisors of negro schools in several southern states	20,000
Schools for negro students in the south	35,000

A NEW chair of bacteriology is to be founded in Edinburgh University under a bequest from Mr. Robert Irvine, of Royston, Granton. *Nature* states that at his death, eleven years ago, Mr. Irvine bequeathed 230 shares of £10 each in a company for developing the resources of Christmas Island for the purpose of establishing the chair when the interest from the shares should reach £25,000 or £30,000. The accumulated dividends on these shares now reach more than £30,000. It is understood that £25,000 will go towards the maintenance of the professorship, and that the remaining £5,000 will be used in providing the class-rooms, laboratories and the necessary equipment.

DR. P. M. DAWSON, a graduate of Johns Hopkins University, and of its medical school, and for eleven years a member of its physiological staff, has been appointed instructor in physiology at the University of Wisconsin Medical School.

THE following promotions and new appointments have been made in the Stanford University Medical Department: Dr. Thomas Addis has been promoted to associate professor of medicine, Dr. E. C. Dickson and Dr. W. W. Boardman have been made assistant professors of medicine; Dr. Leo Eloesser and Dr. F. E. Blaisdell have been made assistant professors of surgery. Dr. R. G. Brodrick, of the San Francisco Board of Health, has been appointed assistant clinical professor of hygiene and public health. In the division of medicine Dr. W. F. Schaller has been made assistant clinical professor, assigned to neurology, and Dr. J. M. Wolfsohn, clinical instructor, assigned to neurology. Dr. A. A. O'Neill has been promoted to clinical instructor in medicine and Dr. G. A. Rothganger has been appointed instructor in surgery.

DISCUSSION AND CORRESPONDENCE

THE CALIFORNIA ACADEMY OF SCIENCES

THE California Academy of Sciences in San Francisco is an institution of about 400 cor-

porate members. The academy is endowed with property approximating a million dollars in value, with the income of which collections and expeditions are maintained, and curators and other scientific and administrative employees are engaged. The members elect anually a board of seven non-salaried trustees, who fix the salaries of employees and otherwise administer the business affairs of the institution; and a non-salaried council, consisting of the president, two vice-presidents, two secretaries, the treasurer, the librarian and the director of the museum of the academy. The council plans the scientific work of the academy, appoints the curators, and recommends their salaries to the trustees.

Leverett Mills Loomis became curator of ornithology in the academy June 12, 1894, and has held the position continuously since that time. At the annual election in January, 1902, he was elected director of the museum, and was reelected to this office each year until and including 1912. In December of 1912 the nominating committee of the academy, regularly selected by the council and trustees in joint meeting, presented for 1913 a ticket of officers the same as the incumbents during 1912, with the sole exception that another candidate was nominated for director of the museum in place of Mr. Loomis. Although there is constitutional provision for contesting elections, no such contest was made, and Mr. Loomis's tenure of the directorship thereby came to an end with 1912.

During January and the first half of February, 1913, the council reappointed—and the trustees subsequently voted salaries for—all curators and assistants who had served during 1912, excepting Mr. Loomis, who was not reappointed as curator of ornithology.

At the stated meeting of the academy, that is to say, of the corporate members, on February 17, 1913, notice was given that the following resolution would be offered at the next stated meeting, and notice thereof was ordered sent to all members:

That the academy regrets the action of the council in not recommending to the trustees the appointment of L. M. Loomis as curator of ornithology, for the year 1913. Mr. Loomis has held this office for more than eighteen years, has twice built up a unique collection of birds for the academy, and his integrity, scientific competence and executive ability are unquestioned. The directorship of the museum is an elective office; the executive curatorship of the academy, though appointive, is an adjunct to the directorship, and may therefore justifiably go with it; but the curatorship of ornithology, like all other departmental curatorships, should be bestowed and reawarded only on the basis of merit and service. The failure to reappoint Mr. Loomis would therefore be a breach of fairness on a point of policy in which all reputable scientific institutions are in accord. It could be construed only as the intrusion of personal jealousies or political enmities into the field of scientific service, and would accordingly bring the academy into bad repute as to its equity in dealing with scientific employees. The academy therefore earnestly requests its council to appoint Mr. Loomis curator of ornithology for 1913, and urges upon its trustees to engage Mr. Loomis to take charge of the department which he has so long, so faithfully and so successfully administered, at the salary which it has been and is the practise to pay to academy curators giving full time to their duties.

At the stated meeting of March 3 a substitute for this resolution was offered by the original proponent, and adopted as follows by the academy:

As the council at recent meetings has failed to recommend the reappointment of L. M. Loomis to the curatorship of ornithology, and as it seems that said action could not have been made with all bearings of the question in mind, the academy herewith respectfully requests the council to appoint Mr. Loomis curator of the department of ornithology, and urges upon its trustees to engage him to take charge of this department, at the salary which is customarily paid by the academy to curators giving full time, with the following considerations in view: the long service of Mr. Loomis as a curator in the academy; the success achieved by him in accumulating large and valuable collections of birds; and the moral basis of the relation of an institution to employees of long standing.

At the next stated meeting of the academy, on March 17, 1913, the following communication from the council was read:

SAN FRANCISCO, CAL.,
March 17, 1913.

TO THE MEMBERS OF THE CALIFORNIA ACADEMY OF SCIENCES:

Having been officially notified of your request as adopted by resolution at the stated meeting of the academy on March 3, that Mr. L. M. Loomis be reappointed curator of the department of ornithology at the compensation which is customary for curators devoting full time to the affairs of their departments, your council desires to assure you that this request is receiving their earnest and most serious consideration.

For the council,
C. E. GRUNSKY,
President
J. W. HOBSON,
Secretary

At the stated meeting of April 7 the council reported to the academy that it had adopted the following resolution:

Having under consideration the request of the academy that the council reappoint Mr. Loomis curator of the department of ornithology for the current year, be it

Resolved, that it is the sense of the council that such reappointment would not be for the best interests of the academy.

Upon presentation of this report from the council, the following resolution was moved and was adopted by the academy:

The academy condemns and disavows the refusal of its council to reappoint L. M. Loomis curator of ornithology, without any charge having been brought against him after eighteen years of faithful and efficient service, as an act of unfairness, and as bringing reproach on the name and equity of the academy.

A. L. KROEBER

UNIVERSITY LIFE IN IDAHO

TO THE EDITOR OF SCIENCE: In reply to Professor Kellogg's letter in the issue of SCIENCE, May 16, 1913, regarding the reported dismissal of Professor Aldrich, of the University of Idaho, I may say that I have not made any recommendation regarding Professor Aldrich's tenure of office to the board of regents, nor to any member of the board—nor have I been asked to do so. I am informed that the action of the board was undertaken on its own responsibility and in fulfilment of its public trust, and the action was confirmed by the new board of education organized for all of the educational institutions of Idaho. I had no part in either proceeding. Accordingly, I am not entitled to share in either the credit or the criticism of the result. The rest of Professor Kellogg's letter is likewise unsupported in fact.

JAMES A. MACLEAN,
President, University of Manitoba

THE COTTRELL PROCESS FOR DEPOSITING DUST AND SMOKE

MR. LINN BRADLEY, of the Research Corporation, recently gave a lecture on the Cottrell Process[1] before the Lehigh Valley Section of the American Chemical Society. It was my privilege to help Mr. Bradley in his experimental demonstration of the process, and I suggested to Mr. Bradley a modification which proved to be very satisfactory for the lecture table.

A glass tube two inches in diameter and four or five feet long is supported in a horizontal position with a heavy wire or metal rod lying along the bottom of the tube and connected to one terminal of a small Holtz machine. A very fine wire is stretched through the tube and supported on two glass columns beyond the ends of the tube, and this fine wire is connected to the other terminal of the electric machine. The best procedure is to keep the machine running continuously with its terminals short-circuited. Then the tube is filled with any kind of smoke, the short circuit is quickly removed, and the smoke is seen to be deposited very quickly indeed.

Those who are not familiar with the process may be interested to know the action which takes place, which is as follows: The voltage between the fine wire and the heavy wire or rod is sufficient to cause a continuous corona

[1] The Cottrell process has been placed in the hands of the Research Corporation of New York City; any proceeds which may come from the practical use of the process are to go to the Smithsonian Institution of Washington.

discharge from the fine wire. In this corona discharge the air molecules are dissociated into ions and these charged ions quickly attach themselves to the particles of dust or tar. The intense electric field between the two electrodes then drags the particles of dust or tar to the large electrode, where they are deposited.

W. S. Franklin

A LOCAL MAGNETIC STORM

In Science, of March 21, reference is made to a paper just published by the Academy of Science of St. Louis with the above title. In this paper evidence is presented to show that atmospheric ions tend to set like magnets along the lines of the earth's magnetic field. The effect of gusts of wind in disturbing these ions, and in thus producing continual swaying of the lines of force due to variations in permeability, is pointed out.

A more local and somewhat similar magnetic storm may be artificially produced as follows:

Suspend a needle on a silk fiber. Provide it with a mirror, telescope and scale. Partially compensate the effect of the earth's field by bar magnets set in parallel position. Place two bar magnets on opposite sides of the needle, as in the Gaussian method of deflection. Place a plate of glass over one magnet, and sprinkle iron filings upon it. The deflecting effect of that magnet is increased. The needle no longer lies in the magnetic meridian. Balance the effect on the needle by adjustment of the other deflecting magnet and tap the plate. The permeability of the space around the magnet is again increased. A new readjustment may be made. Disturb the iron filings by means of a brush, applied to any small area of the plate. A magnetic storm is thus produced. If the filings were free to move without friction, they would all respond to the disturbance. The needle does respond. If the filings are made to accumulate near the poles, the deflecting effect of the magnet is greatly increased. If the magnet is supported at its middle part so that it is lifted above the plate of glass, the poles may be loaded with iron filings. The apparent magnetic moment of the bar may thus be increased about 8 or 10 per cent. Such a magnetic storm as is thus produced in the surrounding space appears to be similar to that produced in the field of the earth, when atmospheric ions accumulate around the magnetic poles of the earth. If any of these Faraday lines are disturbed, they are all disturbed. The balanced needle tells the story.

It seems very probable that the daily variations in the earth's field may be explained as due to this change in permeability brought about by ionization of the air by sunlight. The lines of force sway in opposite directions during the forenoon and afternoon of each day, their lateral motion being greatest in the equatorial belt. There is also apparently a similar swaying in a vertical direction.

In the forenoon the north end of the needle swings towards the west in the northern hemisphere, while the south pole swings towards the west in the southern. In the equatorial belt the needle suffers no change. These daily variations are modified by summer and winter conditions, as they should be if the above explanation is valid.

Francis E. Nipher

PLUS AND MINUS

In a review of my book, "On the Foundation and Technic of Arithmetic," in Science, April 18, 1913, Professor Cajori, after quoting a sentence, says:

> In view of the fact that historians have been in doubt as to the exact origin of + and —, the authority for Halsted's categorical statement would be interesting.

Hoping the readers of Science may be of the professor's mind, I venture an outline.

Minus, as the oral rendering of the symbol —, takes a sense which did not exist in Latin of any period. Murray says it probably originated in the commercial language of the middle ages. In Germany the Latin words *plus* and *minus* were used by merchants to mark an excess or deficiency in weight or measure. The earliest known examples of the

modern sense of *minus* are German. In the *Bamberger Rechenbuch* (1483) the tare to be deducted from the weight of a package is called *das Minus*. An Italian writer of the fourteenth century used *meno* to indicate the subtraction of a number to which it was prefixed. The symbol itself, —, De Morgan, most sound and erudite of mathematicians, says arose as a merchant's mark. Its adoption was helped by its likeness to the *obelus* used by ancient critics to indicate that a passage should be removed from the text. This obelus or obelisk was a straight horizontal stroke, either simple (—), or with a dot above and one below (÷), and in Denmark the sign ÷ is used for *minus*.

English examples of *plus* do not occur so early as those of *minus; e. g.,* 1481–90 *Howard Househ. Bks.* (Roxb.) 417, v. yerdys, mynus the nayle, welwet blake. Cajori says Eneström shows "that with Widman + meant simply 'und' (and)," but how can this be brought to tally with the fact that Widman explicitly directs that the signs — and + be read *minus* and *mer* (mehr)? He uses them as signs already well known in his "Behende und hübsche Rechnung auf allen Kauffmannschafft" (1489); "was — ist, das ist minus, und das + ist das mer."

The adoption of the form + would be greatly helped by its likeness to a form of &=et, and Widman seems to have used the long preexistent form + in the two senses, *mehr* and *et.*

GEORGE BRUCE HALSTED

SCIENTIFIC BOOKS

Schutzfermente des tierischen Organismus. Ein Beitrag zur Kenntnis der Abwehrmassregeln des tierischen Organismus gegen Körper-, blut- und zellfremde Stoffe. By EMIL ABDERHALDEN. Berlin, Julius Springer. Eight text figures; pp. xi + 110. Paper cover, 3.20 M.; bound, 3.80 M.

In this little pamphlet Abderhalden gives an interesting survey of a method which the living organism employs to protect itself from the effects of foreign soluble substances which have entered its circulating juices. Under normal conditions, for example, proteids do not reach the tissue cells in their native state, but only as fragments. This degradation of proteids is normally accomplished by the ferments of the gastro-intestinal canal, and some of the degradation products, after absorption, are then synthesized by the tissues into its own characteristic proteid. Native foreign proteids in the circulation are useless and often directly harmful to the tissue cells. However, when this contingency occurs experimentally or through disease, the invaded body is not entirely helpless, but digestive ferments are formed in the circulation, possibly from the leucocytes, which attack the foreign proteid and digest it. These protective ferments are formed very swiftly and have been demonstrated by Abderhalden in the plasma or serum twenty-four hours after the subcutaneous injection of the foreign proteid, while the plasma or serum of normal, non-injected individuals shows no trace of this ferment.

Similar results were obtained by Abderhalden when carbohydrates were injected, or when fats were driven unchanged into the blood by forced feeding. Here again he was able to show the presence of ferments in the blood which were able to split the foreign substance.

These facts were established by Abderhalden and his pupils largely through the use of the polariscope. When optically active or racemic substances are split by ferment action, the optical activity of the mixture changes and this change shows, in the first place, that a decomposition has occurred; in the second place, the character of the change may show what substances have been formed, provided that the chemical structure of the original substance used is accurately known, which is the case with many of the optically active polypeptids.

The facts briefly mentioned above have received an important application in the diagnosis of pregnancy. The circulation of the pregnant organism contains cells from the chorionic villi, and the maternal body reacts to these cells by forming peptolytic enzymes

not present in the non-pregnant individual. If now the serum or plasma of a pregnant woman is added to peptone prepared from human placental tissue and the mixture observed by the optical method, the initial rotation changes, while with serum from a non-pregnant woman, the initial rotation remains unaltered. As this phenomenon could be detected as early as the first month of pregnancy, the procedure promises to be of great value in the differential diagnosis between extra-uterine pregnancy and tumors of the adnexa. It may, perhaps, be added that this ingenious method apparently does not remove all the difficulties and doubts which surround the early diagnosis of pregnancy, for recent investigations seem to show that a positive reaction may also be obtained under other conditions than pregnancy.

The booklet may be recommended as a very readable, stimulating summary of a large number of investigations by Abderhalden and his pupils.

J. Auer

Rockefeller Institute

Methods for Sugar Analysis and Allied Determinations. By Arthur Given, B.S. Philadelphia, P. Blakiston's Son & Co. 1912. Pp. 75. Price $2.00 net.

According to the preface, this book has been made, because, as the result of ten years' experience, the author has found that "it has become increasingly evident that the present methods as given in many of the books on sugar analysis and in the A. O. A. C. methods are not sufficiently explicit as to the proper method for a particular case, thereby confusing the novice, and making it difficult to secure uniform results. . . ."

The methods presented by the author are those which he, "from long practise on a very large variety of substances, considers to be best adapted for the purposes in hand."

In its limited range of seventy-five pages the book endeavors to cover the analysis of sugar-cane, cane-sugar and beet-sugar and their derived products, maple-sugar and maple-syrup, honey, commercial glucose, dextrin, starch, condensed milk, milk chocolate, etc. A few tables and illustrations are scattered through the text.

There is undoubtedly room on the shelf of many an analyst for a work which shall give tested and tried methods for the analysis of sugar and allied, saccharine, products. The author has brought together some material of value for this purpose; there is however—in spite of his conviction—room for considerable doubt as to whether his choice of methods would always commend itself to the approval of other experienced analysts.

In discussing the determination of sucrose in raw sugars, the use of Wiley's correction factor is recommended to obtain "the true polarization in sugars polarizing over 90°," if the temperature of polarization varies from 20° C., and then the author goes on to state that such correction is not applicable "where the reducing sugars exceed 3 per cent., as differences in temperature affect the reducing sugars more strongly than sucrose."

It would be interesting to learn why and how this arbitrary limitation of 3 per cent. has been decided upon by the author, and how he would obviate the disturbing influence of the precipitate-error in clarification which tends to offset the reduction in the specific rotatory power of sucrose caused by an elevation of temperature above the temperature at which the polariscope has been graduated.

The concise, not to say terse, manner of expression employed in the book is a good feature, yet a few additional words of explanation would not have been out of place in several instances, for example in giving the formula to be used in the Clerget method (p. 11). The novel way of printing the names of several of the more common sugars (p. 36) is apt to introduce more confusion in this already troublesome issue and the data given in that table are not always correct—thus, f. i. raffinose is hydrolyzed by invertase into d-fructose and melibiose, and not into d-glucose and d-galactose, as stated. Hydrolization of raffinose into d-galactose and sucrose is effected by emulsin.

F. G. Wiechmann

Principles of Economic Zoology. By L. S. DAUGHERTY, M.S., Ph.D., Professor of Zoology, State Normal School, Kirksville, Mo., and M. C. DAUGHERTY, Kirksville, Mo. Philadelphia and London: W. B. Saunders Company. 1912. Cloth, 12mo. Pp. 410. 301 illustrations. $2.00 net.

This recent text-book presents a number of commendable features and adds another to the rather numerous list of available text-books for the beginner in zoology. It seems more particularly adapted for the normal school work in which the authors are engaged, and this perhaps accounts for the effort to include a very large number of examples rather than to give a more detailed and exact description of representative forms in the principal groups of animals. Possibly the great number of forms mentioned would be confusing, but in the hands of a skillful teacher the book could certainly be very useful in the extending of acquaintance with animal forms in general. The economic feature of the work, which has been emphasized in its title, will make it welcome in many schools where attention to this phase of the subject is desired. While these references are usually brief they generally sum up in fairly compact form the more important economic points, and are quite suggestive for references to more extended works in this field.

The illustrations are numerous, usually well selected and very well printed, and add a very important feature to the book.

One point which seems somewhat of a blemish is the inclusion of a discussion of economic or other matter referring to an entirely different class under a sub-heading which is restricted to some minor division of the group, for example pages 40, 44 and 70, the discussion of economic importance included in a paragraph under minor classes in the branch, relate for the most part to species included in entirely different classes and without especial attention of the student might very likely be supposed to refer to the class in which the paragraph occurs. This fault is one which might easily be corrected by a different arrangement of sub-headings.

The substance in general seems to be carefully stated and while there are some errors, due no doubt to lack of first-hand knowledge, the preparation shows care, and while stated to be essentially a compilation, the authors are to be commended for the success shown in selection and presentation of material.

In typographical respects the book is very satisfactory and a credit to the publishers.

HERBERT OSBORN

THE MINERAL WEALTH OF CANADA

ALTHOUGH the discussion of reciprocity with Canada is now quiescent, yet all citizens of the United States are naturally interested in the development of our sister country. This is especially true of the readers of SCIENCE, because Canada has given to this country such a large number of eminent, influential and successful educators and scientists.

A recent publication of the Canadian Department of Mines gives us many items relating to the mineral wealth and to some of the resulting manufactures that ought to be of importance to our own people. This work is entitled "A General Summary of the Mineral Production of Canada during the Calendar Year 1911," by John McLeish, B.A., chief of the Division of Mineral Resources and Statistics.

From this we learn that the total value of the mineral products of Canada in 1911 was $103,220,994, or $14.42 per capita. The production was distributed amongst the various Canadian provinces arranged in order of the values as follows: Ontario, $42,796,162; British Columbia, $21,299,305; Nova Scotia, $15,409,397; Quebec, $9,304,717; Alberta, $6,662,673; Yukon, $4,707,432; Manitoba, $1,791,772; Saskatchewan, $636,706; and New Brunswick, $612,830.

Of these mineral products the metallic were valued at $46,105,423; the non-metallic at $57,115,571, of which $22,709,611 were for structural materials and clay products.

As a matter of comparison it is here pointed out that for the same year 1911 the mineral products of the United States, according to our

National Geological Survey, amounted to $1,918,326,253, of which $672,179,600 were for metallic and $1,245,896,653 were for non-metallic, with a value of $250,000 for materials not differentiated.

The table here given shows the relative values of some of the important mineral products common to Canada and this country. In those given Canada surpasses the United States in the value of its products only in nickel; but a few decades will doubtless see a great change in the relative values of the arsenic, asbestos (chrysotile), corundum and products of the two countries.

	Canada Value	United States Value
Metallic		
Pig iron	$12,307,125	$327,334,624
Silver	17,355,272	32,615,700
Gold	9,781,077	96,890,000
Copper	6,886,998	137,154,092
Lead	827,717	36,553,320
Zinc	101,072	30,964,794
Nickel	10,229,623	127,000
Non-metallic		
Coal	26,467,646	626,366,876
Natural gas	1,917,678	74,127,534
Petroleum	357,073	134,044,752
Peat	3,817	272,114
Clay products	8,359,933	162,236,181
Cement	7,644,537	66,705,136
Gypsum	993,394	6,462,035
Lime	1,517,599	13,689,054
Sand-lime-brick	442,427	897,664
Slate	8,248	5,728,019
Stone	4,428,757	77,108,567
Corundum and emery	161,873	6,778
Grindstones	52,942	907,316
Arsenious oxide	76,237	73,408
Phosphate rock	5,206	11,900,693
Pyrite	365,820	1,164,871
Asbestos	2,922,062	119,935
Mica	128,677	355,704
Mineral waters	223,758	6,837,888
Graphite	69,576	288,465
Salt	443,004	8,345,692
Talc	22,100	1,646,018

The mineral statistics were first collected for Canada in 1886, in which year the total value was $10,221,255, since which time the values have in general increased up to 1910, when they were $106,823,623 or the maximum. The falling off in 1911 is attributed to the prolonged strike of the coal miners in the Province of Alberta and the Crowsnest district of British Columbia, as the resulting scarcity of coal and coke in those provinces seriously interfered with the smelting operations.

A matter of practical value to the United States is the question of the mineral exports and imports of the Canadian provinces. The total value of the exports of mine products and the manufactures thereof was $52,546,593, of which $11,424,905 was for manufactures. Nearly all of the Canadian copper, nickel and silver are exported, as are a large part of the gold, asbestos and mica. The manufactures of mine products exported are chiefly iron and steel goods, aluminum, calcium carbide, lime, acetate of lime and coke. Of the exports $33,129,505 were sent into the United States; to the United Kingdom $6,726,015; while the next largest amount was to Newfoundland and Labrador, $580,632.

The imports into Canada of mineral products, chiefly in a manufactured or semi-manufactured condition, were in 1911 valued at $181,839,077. Of these imports iron and steel and the manufactures thereof amounted to $93,000,000; coal, ores, diamonds (unset) and bort, asphaltum, alumina, clays, etc., equaled $48,000,000; copper, gold, silver, lead, platinum, tin and zinc reached $18,750,000; while petroleum and clay products exceeded $11,000,000.

In view of the above facts the following excerpt from the report is of interest:

> The great excess of imports over exports would seem to indicate the existence of large opportunities for the development not only of Canada's mineral production, but also of many manufacturing industries which utilize mine products as raw materials. The fact, however, must not be overlooked that the geographical situation of Canada and the United States, separated by an imaginary barrier 3,000 miles in length, evidently results, notwithstanding the tariffs on both sides, in a mutually advantageous interchange of trade. Then we find large exports as well as imports of coal and of agricultural implements. The con-

tinued large export of crude unrefined ores and metal products and the corresponding imports of refined and manufactured metal products still point to opportunities for the development of metallurgical industries as well as industries for the treatment, refinement and manufacture of non-metallic products.

Owing to our contiguity, our mutual relations, our essential unity of race and general characteristics and identity of language, we can but wish our northern brethren success in the development of their rich mineral country.

AFTER the preceding remarks relating to this subject were in type, but not yet published, a recent "Preliminary Report on the Mineral Production of Canada during the Calendar Year 1912, prepared by John McLeish, B.A.," has been received, although the data are subject to revision for a final report.

The total mineral production is stated for 1912 to be $133,127,489, or $29,906,495 over that of the preceding year, and $26,303,866 over that of 1910, heretofore the banner year. So notable an increase points towards a more general prosperity. The relative rank in production of the different provinces remains as in 1911, except that Alberta and Quebec have changed places, the product of the former being valued at $12,110,960 and the latter $11,675,682. For Ontario the value is $51,023,134, for British Columbia $29,555,323, and for Nova Scotia $18,843,324.

Of the value of the total production, as is quite general, the non-metallic is the greater or $71,949,500, while the metallic is $61,177,989.

The value of some of the more important Canadian mineral products are given in the table below.

	Value
Coal	$36,349,299
Silver	19,425,656
Pig iron	14,550,999
Nickel	13,452,463
Copper	12,709,311
Gold	12,559,443
Clay products	9,343,321
Cement	9,083,216
Stone	4,675,851
Asbestos and asbestic	2,979,384
Natural gas	2,311,126
Lime	1,717,771
Lead	1,597,554
Gypsum	1,320,883

The production of petroleum has been steadily falling off for the past five years, the value for 1912 being $345,050. The values of the production of copper, silver and gold have increased, especially in the case of gold from the Porcupine District. In brief it may be said that except for petroleum, the values of all the Canadian productions have increased since 1911.

For 1912 the value of the exports of mine products and of the manufactures of mine products has been $68,585,286, the chief ones being in order of value: silver, gold, copper, coal, nickel, asbestos, automobiles and aluminum.

By comparing the reports of previous years the mineral industries of Canada present, on the whole, very encouraging features for our northern neighbors and prove that a rapid development is taking place.

M. E. WADSWORTH
UNIVERSITY OF PITTSBURGH,
March 19, 1913

SPECIAL ARTICLES

ARTIFICIAL PARTHENOGENESIS IN FUCUS

THE occurrence of natural parthenogenesis or the development of the gametes without fertilization has been reported for several forms among the Phæophyceæ. Berthold and Oltmanns observed it in *Ectocarpus siliculosus,* which possesses, besides zoospores, gametes of two sizes. Both male and female gametes even in the same culture under certain conditions develop parthenogenetically. The question has been raised whether the so-called zoospores are not parthenogenetic gametes. Sauvageau observed that in *Giffordia secunda* antheridia were produced in greater numbers in July, but that none were formed in August or later, while numerous oogonia appeared at this season, many of whose

eggs cleaved very slowly without fertilization. The older observations of Thuret and of Crouan that the eggs of *Cutleria* develop without fertilization have been confirmed by Church, who reports that on the English coast *Cutleria multifida* develops mostly parthenogenetically, female plants being hard to find in August, and that scarcely any occur in the latter part of the season, the eggs developing without fertilization. As was previously observed by Thuret and Bornet, Williams has more recently found that the unfertilized eggs of *Dictyota* and of *Haliseris* segment a few times and then die.

It is evident that the Phæophyceæ show a strong tendency toward parthenogenetic development and that natural parthenogenesis may play an important part in the life history of several species. None of the Fucaceæ, however, have been reported as being able to develop without fertilization, although Thuret mentions that unfertilized eggs of *Fucus* kept for several days become pear-shaped and that a cellulose wall is sometimes present. Thuret's observations have not been supported by Farmer and Williams, who have never been able to observe cellulose walls around unfertilized eggs. My own observations are in harmony with those of Farmer and Williams. While working at the Marine Bioogical Laboratory at Woods Hole, the past summer, it seemed worth while to apply to *Fucus* eggs some of the well-known experimental methods used by Loeb, Winkler, Delage, Lillie and others, whereby unfertilized eggs of certain invertebrates have been made to segment under the influence of artificial physical and chemical stimuli.

Fucus vesiculosus, a diœcious species, occurs near the shores between tide marks at Woods Hole, and plants, both in the vegetative and reproductive conditions, are usually abundant. The spermatozoids and oospheres are usually discharged sparingly during ebb tide and abundantly during flood tide. Plants were collected during ebb tide, the distal portions removed and placed in dishes on ice over night. Care was taken that the conceptacles bearing eggs and sperms were kept separate. When it was desired to obtain the eggs and sperms, dishes containing conceptacles were filled with fresh sea-water, or after first exposing the conceptacles to a hypotonic sea-water, when eggs and sperms were discharged in large numbers. The freshly extruded eggs drop to the bottom of the dishes and can be taken up with a pipette and transferred to watch glasses for experiment. After a short time the eggs show a tendency to adhere very firmly to the bottom of the watch glasses so that fluids can easily be poured off and others added without losing the eggs.

The process of fertilization in *Fucus* has often been studied, and the details of development were especially studied by Thuret and later by Oltmanns. If the mature eggs and sperms are mixed together in the same dish in sea-water, the sperms collect in great numbers about the egg, and attaching themselves to the periphery cause the eggs to rotate rapidly by lashing the water with the cilia. Soon the eggs lose the power of attracting the sperms. They cease their rotation and settle down. Such eggs are fertilized. Farmer and Williams have shown that within five minutes after mixing the sexual cells the sperms have entered many eggs and within ten minutes the sexual nuclei fuse. Soon after fertilization a delicate membrane or cell wall is formed about the periphery of the oospore. As noted by Farmer and Williams, the character of the cytoplasm changes markedly, tending to assume a definitely radiating character, the lines radiating from the nucleus as a center. The oospores rest for about twenty-four hours, during which time there is a rapid increase in the thickness of the cell-wall and a further change occurs in the structure of the cytoplasm like those described by Farmer and Williams. At the periphery of the fertilized egg, just below the wall, the cytoplasm shows a definite alveolar structure.

After some time many of the oospores assume a pear-shaped form and by the next day all have divided. The first division, as has been observed by Rosenvinge and others, is at

right angles to the direction of the light. In the main my observations on the physiology of germination are in accord with those of Farmer and Williams. In watch glasses, placed on a laboratory table, the first division is usually at right angles to the bottom of the watch glass and at right angles to the direction of the light. Abnormalities in cleavage and development as described by Küster were sometimes, but seldom, observed. The cell away from the light is the rhizoidal cell, while from the other cell the young thallus develops. The subsequent cell divisions and growth of the plantlets in watch glasses follow the descriptions of Thuret and of Oltmanns and need no special mention. In watch glasses placed in larger dishes of sea-water, young plants of about 25 cells were grown in the laboratory. No attempt was made to rear the plants beyond these young stages.

In plants used to induce cell division by artificial means great care was taken to prevent contamination by sperms. The female plants were carefully washed with fresh water to kill any sperms which might adhere to them. None of the eggs obtained from such sterilized plants ever developed in the numerous controls, which were run in connection with the experiments, showing beyond a doubt that the female plants treated were absolutely sterile.

Loeb has shown that, when unfertilized eggs of the sea-urchin are placed for one and one-half to two minutes in a mixture of 50 c.c. of sea-water + 3 c.c. of 0.1 *m* acetic, butyric or other fatty acid and then transferred to normal sea-water, a fertilization membrane is formed. This method was applied to unfertilized *Fucus* eggs. In experimenting with the eggs those used at any one time were always divided into three lots. One lot was used as a control, another was fertilized and the third was treated with the solution. If a single egg in the control formed a cell-wall, which seldom happened, the three lots were discarded. In case the eggs were treated with acetic or butyric acid, as above described, a large number of them formed in about ten minutes a membrane or cell-wall which was exactly similar to the one formed about normally fertilized eggs. By plasmolyzing the eggs the membrane is readily seen. Eggs not treated with a solution or not fertilized undergo cytolysis and degenerate. In any case many of the eggs failed to develop, but about one fourth as many formed membranes under the influence of the solutions as were formed about fertilized eggs. After the formation of the membranes if the eggs are placed in hypertonic sea-water, 8 c.c.–10 c.c. of 2.5 *m* NaCl or KCl + 50 c.c., sea-water for 30 minutes and are then brought back into normal sea-water, development continues. Nearly all of the eggs which have formed a membrane become pear-shaped, showing a rhizoidal papilla, and by next morning have cleaved. The rhizoidal cell is cut off and one or more cleavages have taken place in the other portion of the sporeling. If the cultures are properly aerated, sporelings develop resembling in every respect those grown from fertilized eggs. In place of sea-water containing a fatty acid, solutions of various other cytolytic substances were used, but none stimulated membrane formation or development as well as the acids.

With regard to the first formation of the cell-wall over the surface of isolated masses of plant protoplasm, it is usually attributed to a process of secretion by the outer layer. That the process is a rapid one is shown by the fact that in *Fucus* eggs a cell-wall is formed in ten minutes after the entrance of the sperm. Cell-wall formation may also be artificially induced, as shown above, by various substances. In some cases a cell-wall may appear under certain conditions on the surface of plasmolysed protoplasts in fifteen minutes, as has been shown by Klebs, Palla and others, while in other cases hours are required for wall formation. It would appear that the action of the acids in inducing a cell-wall to be formed about the unfertilized *Fucus* eggs is similar to the action which calls forth membrane formation in the animal egg. Considerable evidence exists indicating that the essential con-

dition for the formation of the fertilization membrane in many animal eggs is an increased permeability of the plasma membrane for substances which pass out and harden in contact with the sea-water. The rôle of the acid, etc., in membrane formation is held by many to be the increasing of the permeability of the plasma membrane of the egg.

That the first effect of the sperm of the Fucaceæ upon the egg is to cause cell-wall formation, conditioned as it seems to me by a momentarily increased permeability of the plasma membrane just as in certain animal eggs, is apparent from the observations of several investigators. Farmer and Williams furnish remarkable evidence showing that the entrance of the sperm supplies the stimulus which leads to the formation of the cell-wall in *Halidrys*. In this form pieces of the oospheres are sometimes pinched off during extrusion. These observers note that such pieces sometimes attract the sperms and become fertilized, surrounding themselves with a cell-wall in the normal way. The cases of merogony induced by Winkler in *Cystosira barbata* may, I think, be explained by assuming that the sperms increase the permeability of the non-nucleated fragments, as well as being the underlying cause of further development. In the normally fertilized eggs of *Halidrys* Farmer and Williams note that the entrance of the sperm causes the eggs to swell and become more transparent. In some cases movements of vacuoles are discernible and the nucleus may change its position. They conclude that these alterations ensue as a definite result of the stimulus given by the sperm. The fertilized egg becomes covered by conical projections, from each of which a fine thread projects, consisting of a series of droplets. After 3–5 minutes the fertilized egg resumes its spherical shape and decreases in diameter. They also observed that the sperms were repelled from fertilized eggs and conclude that this is due to the excretion of some substance which exerts a negative chemotactic and injurious effect on the sperms. Such eggs at once become invested in cell-walls, while others not exhibiting these phenomena after a time degenerate.

The results of my experiments, in which cell-wall formation and subsequent development were induced in unfertilized eggs of *Fucus*, and the data mentioned above, seem to show that the first effect produced by the sperm upon the egg is purely superficial, causing an increase in the permeability of the plasma membrane. These conclusions are in harmony with those of certain animal physiologists. Therefore, theoretical considerations as to the causes of the change in permeability and the stimulus to further development need not be discussed here.

As yet I have been unable to investigate the nuclear behavior of the parthenogenetic plants of *Fucus*. Farmer and Williams, agreeing with Strasburger, hold that the *Fucus* plant contains the diploid number of chromosomes and that the reduction to the haploid number occurs during the first division in the oogone and in the antherid. Since the eggs of these plants induced to develop without fertilization contain the haploid number of chromosomes, one can assume, unless a regenerative doubling in their chromosome number occurs, that the nuclei of the sporelings contain the haploid number. It would be of interest to grow these parthenogenetic sporelings to sexual maturity and to investigate the chromosome behavior especially during oogenesis and spermatogenesis. Hoyt has carried sporelings of *Dictyota* to maturity by sowing the spores on oyster shells, and transferring these to the open water after the sporelings had become firmly attached. Lewis had used similar methods successfully with the sporelings of certain Florideæ. Fertilized eggs of *Fucus* when allowed to settle down on oyster shells in the bottom of dishes become firmly attached and produce the sporelings. *Fucus* eggs induced to develop by artificial stimuli also produce sporelings on oyster shells. For lack of time I was unable to transfer them to the open water, but the method is suggestive.

J. B. Overton

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ON THE COLLOID-CHEMICAL ACTION OF THE DIURETIC SALTS[1]

THIS paper reports a further series of experiments on rabbits which show that *the colloids of the cells and of the juices which bathe them (blood and lymph), and the state in which these exist determine in the main the amount of water such cells and body fluids hold under both normal and abnormal conditions.*

The maintenance of a urinary secretion depends upon two factors, first, upon a supply to the kidney of "free" water out of which to make urine, and second, upon the ability of the kidney cells to do the work necessary in transferring the water from the blood into the uriniferous tubules. Urinary secretion may fail through interference with either of these factors.

The intravenous injection of any amount of blood, blood serum, or a hydrophilic colloid in which all the water is bound to the colloid, is followed by no increase in urinary secretion. This is because no "free" water is given. The same amount of water when given "free," as in the form of a saline solution, is followed by a prompt increase in urinary flow.

When equal amounts of sodium chloride solution are injected we get increasingly greater amounts of urine with progressive increase in concentration of the salt. This is because the salt dehydrates the body tissues, and the "free" water thus obtained is added to that which is being injected. The salt owes its action as a diuretic primarily not to any effect upon the kidney, but to its action in dehydrating the colloids of the whole body.

When equal amounts of equimolecular solutions of different salts are injected it is found that the order in which these produce diuresis is the same as the order in which they dehydrate (protein) colloids. Thus in a series of chlorides the metals arrange themselves in the following order, in which that most powerful in producing a diuresis is named last: sodium, magnesium, strontium, calcium. In a series of sodium salts the acid radicals arrange themselves as follows: chloride, nitrate (?), bromide, iodide, acetate, phosphate, sulphate. The greatest diuresis of all is produced by a salt which is made up of a powerfully dehydrating base with a powerfully dehydrating acid, for example, magnesium sulphate.

The diuretic action of these different salts parallels completely their dehydrating effect upon (protein) colloids, a fact which again indicates that they owe their action primarily to their effect upon the body as a whole, acting as diuretics only as they furnish a working kidney "free" water.

The experiments also betray no evidence of an antagonism between monovalent salts such as those of sodium, and bivalent salts such as those of calcium, strontium, etc. Such salts act *synergetically,* not antagonistically, in physiological reactions, just as they do in test-tube experiments on simple protein colloids.

It is impossible to explain these salt effects upon any osmotic basis, for there exists not even the grossest parallelism between the physiological effect and the osmotic pressure of the solutions employed. Our critics have maintained that osmotic phenomena dominate the picture of absorption and secretion in "living" tissues. They have grown willing to grant that the colloidal theory is operative in "dead" tissues. In the described experiments the osmotic element can hardly be found; the colloidal element appears plainly in every one of them. It is needless to add that our rabbits were alive.

The detailed laboratory findings upon which this article is based have been submitted for publication in the *Kolloid Zeitschrift.*

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April, 1913

[1] A preliminary communication.

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and sixty-third regular meeting of the American Mathematical Society was hald at Columbia University on Saturday, April 26, extending through the usual morning and

afternoon sessions. The attendance included fifty-seven members. President E. B. Van Vleck occupied the chair, being relieved by Ex-Presidents H. S. White and T. S. Fiske. The following new members were elected: Professor E. H. Jones, Daniel Baker College; Mr. L. B. Robinson, Johns Hopkins University; Dr. H. M. Sheffer, Cornell University; Dr. W. B. Stone, University of Michigan; Professor F. B. Wiley, Denison University. Six applications for membership were received. Professors D. R. Curtiss and P. F. Smith were elected members of the editorial board of the *Transactions* to succeed Professors Bôcher and White, who retire in the fall.

The following papers were read at this meeting:

E. L. Dodd: "The error risk of the median compared with that of the arithmetic mean."

B. M. Batchelder: "The divergent series satisfying linear difference equations of the second order."

P. M. Batchelder: "The hypergeometric difference equation."

H. J. Ettlinger: "On a generalization of a Sturmian boundary problem."

R. L. Moore: "Concerning pseudo-Archimedean and Vollständigkeit axioms."

J. E. Rowe: "The relation between the pencil of tangents from a point to a rational plane curve and their parameters."

E. G. Bill: "Analytic curves in non-euclidean space (third paper)."

Joseph Slepian: "On the functions of a complex variable defined by a differential equation of the first order and the first degree."

Nathan Altshiller: "On the cubic with a double point."

C. F. Craig: "Ruled surfaces associated with certain rational space curves."

H. M. Sheffer: "The generalized principle of duality in Boolean algebras."

T. H. Gronwall: "On the maximum modulus of an analytic function."

L. L. Smail: "Note on the summability of properly divergent series."

Maurice Fréchet: "Sur les classes V normales."

Maxime Bôcher: "An application of the conception of adjoint systems."

G. D. Birkhoff: "Note on the gamma function."

G. D. Birkhoff: "Solution of the generalized Riemann problem for linear differential equations, and of the analogous problem for linear difference and q-difference equations."

L. P. Eisenhart: "Transformations of Guichard."

E. V. Huntington: "Sets of independent postulates for betweenness (second paper)."

A. D. Pitcher: "On the connection of an abstract set, with applications to the theory of functions of a general variable."

A. D. Pitcher: "Concerning the property Δ of a class of functions."

R. G. D. Richardson: "Oscillation theorems for a system of n linear self-adjoint partial differential equations of the second order with n parameters."

H. H. Mitchell: "On some systems of collineation groups."

H. S. Vandiver: "Symmetric functions formed by certain systems of elements of a finite algebra, and their connection with Fermat's quotient and Bernoulli's numbers."

C. A. Fischer: "The derivative of a function of a surface."

C. T. Sullivan: "Properties of surfaces whose asymptotic curves belong to linear complexes."

S. D. Killam: "A note on graphical integration of a function of a complex variable."

K. P. Williams: "On the asymptotic form of the function $\Psi(x)$."

M. G. Gabba: "A set of postulates for general projective geometry in terms of point and transformation."

W. A. Hurwitz: "Postulates sets for abelian groups and fields."

Edward Kasner: "The interpretation of the Appell transformation."

G. M. Green: "Systems of k-spreads in an n-space."

J. W. Young: "A new formulation for general algebra."

J. W. Young and F. M. Morgan: "The geometry associated with a certain group of cubic transformations in space."

The summer meeting of the society will be held at the University of Wisconsin, Madison, Wis., during the week September 8–13. The last four days of the week will be devoted to a colloquium, at which courses of lectures will be given by Professor L. E. Dickson, of the University of Chicago, on "Certain aspects of a general theory of invariants, with special consideration of modular invariants and modular geometry"; and by Professor W. F. Osgood, of Harvard University, on "Topics in the theory of analytic functions of several variables."

F. N. Cole,
Secretary